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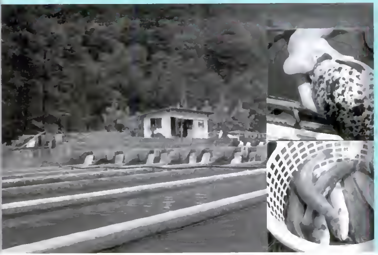
Jakarta, Indonesia



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Regional Workshop on Preparedness and Response to Aquatic Animal Health Emergencies in Asia

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Rome, 2005

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Preparation of this document

This document contains the proceedings, including the texts of 14 papers presented, the Working Group reports and the recommendations resulting from the Regional Workshop on Preparedness and Response to Aquatic Animal Health Emergencies, held in Jakarta, Indonesia from 21-23 September 2004.

The workshop was jointly organized by the Food and Agriculture Organization of the United Nations (FAO) Inland Water Resources and Aquaculture Service (FIRI), the Network of Aquaculture Centres in Asia-Pacific (NACA) and the WorldFish Center (WFC), and was hosted by the Government of Indonesia, Ministry of Marine Affairs and Fisheries (MMAF). The editing, publishing and distribution of the document were undertaken by FAO, Rome.

The workshop was made possible with financial assistance through FAO/TCP/INS/2905 – Health Management in Freshwater Aquaculture and the FishCode Programme of the FAO Fisheries Department.

Abstract

This document contains the proceedings, including the texts of 14 papers presented, the Working Group reports and resulting recommendations of the Regional Workshop on Preparedness and Response to Aquatic Animal Health Emergencies, held in Jakarta, Indonesia, from 21-23 September 2004. The workshop was jointly organized by the Food and Agriculture Organization of the United Nations (FAO) Inland Water Resources and Aquaculture Service (FIRI), the Network of Aquaculture Centres in Asia-Pacific (NACA) and the WorldFish Center (WFC), and was hosted by the Government of Indonesia, Ministry of Marine Affairs and Fisheries (MMAF). The workshop was attended by 51 participants, including national policy-makers and scientists from the Asian region, and international experts and resource persons from both the region and elsewhere.

The papers contained herein cover a wide range of topics related to emergency planning and response to serious outbreaks of aquatic animal diseases, including a review of the history, current status and socio-economic impacts (including implications for international trade) of transboundary aquatic animal diseases (TAADs) in Asia; impacts of exotic diseases on aquatic biodiversity; experiences in the aquaculture and livestock sectors in developing and developed countries in the Asia-Pacific region and elsewhere (e.g. Canada, Norway) in dealing with major disease epizootics (including reviews of recent efforts in Indonesia and Japan to deal the serious outbreaks of Koi herpes virus disease); the role of national governments and the private sector; and analyses of regional needs in areas such as contingency planning, legislation (institutional and regulatory frameworks) and capacity building (training, infrastructure, disease diagnostics, surveillance, monitoring and reporting).

The major recommendations of the workshop are:
(i) at the national level, the capacity and awareness of personnel at producer, disease support and decision-making levels, should be strengthened and adequate resources allocated to support implementation of emergency preparedness strategies; (ii) at the regional level, existing disease reporting systems (e.g. NACA/FAO/OIE Quarterly Aquatic Animal Disease Reports) should be further strengthened to ensure increased sharing of information on national aquatic animal disease status and emerging aquatic animal diseases of significance to Asia; (iii) regional technical support mechanisms (e.g. the NACA Regional Advisory Group) should be used to provide expert teams and information to countries in order to assist in early response to disease problems; (iv) research to support early warning and early response should be targeted to rapid diagnostics (e.g. assessment of the accuracy of Level I diagnosis), epidemiology, risk assessments and biosecurity; (v) detailed post-mortem analyses of the outbreaks of Koi herpes virus (KHV) in Japan and Indonesia should be conducted to understand the actions taken by the government and private sector, the extent of their success and the lessons learned; and (vi) core funding should be allocated at national and regional levels to provide ready resources to respond rapidly to emergencies.

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Foreword

The epidemic spread of aquatic animal diseases is an increasing event in many parts of the world and many countries in the Asia-Pacific region have, to various degrees, suffered the consequences of such serious disease outbreaks. We have witnessed the devastating impacts of epizootic ulcerative syndrome (EUS) in freshwater fish during the 1980s and the 1990s, viral encephalopathy and retinopathy (VER) in marine fish since the 1990s, whitespot syndrome virus (WSSV) in penaeid shrimps from the early 1990s, and the emerging Taura syndrome virus (TSV) in *Penaeus vannamei*. There are still a number of unresolved diseases such as Akoya oyster disease in Japan and abalone mortalities in the People's Republic of China. Since 2002, Indonesia has faced a serious epizootic of Koi herpes virus (KHV), causing large-scale mortalities with significant economic losses among cultured common and koi carp (*Cyprinus carpio*) populations. More recently, during the last quarter of 2003, an outbreak of KHV also occurred in common and koi carp in Japan.

The above examples demonstrate the vulnerability of aquaculture and wild resource production to wide-scale infectious disease emergencies and the significant impacts that new diseases can have on local economies. Unless appropriate health management and biosecurity measures are continuously put in place and effectively implemented, the risk of major disease incursions and newly emerging diseases will continue to threaten the sector. Past experiences in dealing with disease epizootics can provide useful lessons towards better preparedness for and improved responses to similar events when they occur in the future.

In the case of KHV, the affected species is widely traded within and among countries inside and outside the region creating a considerable risk of spreading KHV with the movements of common and koi carp, a situation that can lead to transboundary epizootics. Common and koi carp are important commodities, as food fish and high-value ornamental fish, respectively. Many rural communities depend on koi and common carp to support their livelihoods, both in Indonesia and in several neighboring countries. Effective prevention and control measures, complemented by improved extension services, educational programmes and capacity building for farmers and producers are essential to reduce the risk of transboundary epizootics. A strong national approach, along with a well-planned regional strategy, is required to ensure that the operational capability is in place to respond effectively to disease emergencies. Equally important is a clear understanding by both government and the private sector of the benefits to be gained from investing and participating in emergency response systems.

It is clear from our knowledge and recent experience that the capacity for early detection and effective response to disease emergencies is inadequate in many countries in Asia due to several factors, such as limited diagnostic capacities, lack of information, insufficient human resources and infrastructure and lack of financial resources. Limited understanding of the gravity of the problem often results in failure to provide priority action at national and regional levels. This urgently needs rectifying in order to avoid further introduction of exotic pathogens and spreading of emerging diseases. KHV is a prime example, requiring immediate attention from relevant international research and development agencies, as well as the private sector. Concerted action is essential for controlling this serious epizootic and to regain both consumer and producer confidence.

In order to review and evaluate the national and regional status of emergency preparedness and response to infectious diseases in aquatic animals and to find avenues for providing guidance and assistance for national and regional improvements, the Food and Agriculture Organization of the United Nations (FAO) in partnership with the Government of Indonesia, the Network of Aquaculture Centres in Asia-Pacific (NACA) and the WorldFish Center (WFC) organized a workshop entitled "Emergency Preparedness and Response to Aquatic Animal Diseases". The purpose of the Workshop was to review the regional experiences in responding to disease emergencies, including the work accomplished through an FAO Technical Cooperation Programme project in Indonesia aimed at providing technical assistance to improve national capacity to respond to the ongoing carp disease epizootic. The Workshop was intended to assist Indonesia and other countries in the Asian region to: (i) identify actions to reduce the impacts of KHV on aquaculture and small-scale fisheries; and (ii) strengthen preparedness and response to serious aquatic animal disease emergencies.

The Regional Workshop on Emergency Preparedness and Response to Aquatic Animal Diseases was held from 21-23 September 2004 at the Santika Jakarta Hotel, Jakarta, Indonesia. The Workshop was hosted by the Government of Indonesia, under the patronage of the Hon. Minister of Fisheries. Assistance and support for the workshop was provided by the Office International des Épizooties (OIE) Regional Representation for Asia-Pacific (Tokyo), the Southeast Asian Fisheries Development Center (SEAFDEC), the Norwegian Agency for Development (NORAD), the Danish International Development Agency (DANIDA), the Australian Centre for International Agriculture Research (ACIAR), the Australian Agency for International Devlopment (AusAID) and the United Kingdom Department for International Development (DFID). The 51 participants included experts and policy personnel from the region who are responsible for handling health and disease situations in aquatic and terrestrial environments. It is hoped that the Workshop will prime the concept of emergency preparedness and response among aquatic animal health managers so that future national and regional aquatic production and conservation policy and programme development will take such preparedness plans into consideration.

This document presents the proceedings of the Workshop, including the papers presented, a summary of the Working Group discussions and the resulting recommendations. A separate set of guidelines outlining the procedures for contingency planning, emergency preparedness and response for aquatic animal diseases in developing countries will be published as *FAO Fisheries Technical Paper.* No. 486, Preparedness and response to aquatic animal health emergencies in Asia: guidelines.

Recommendations of the workshop

The recommendations presented below are drawn from the Working Group discussions and the final discussion session of the workshop.

Regional cooperation

National agencies have the primary responsibility for responding to disease emergencies, regional cooperation can provide essential support. Existing regional cooperation in aquatic animal disease control in Asia should be further strengthened to support national efforts to control serious aquatic animal disease outbreaks in the region.

Regional reporting and communications, the NACA/FAO/OIE Regional Quarterly Aquatic Animal Disease Reporting System, should be further strengthened to ensure increased sharing of information on national aquatic animal disease status and emerging aquatic animal diseases of significance to Asia. The regional list of aquatic animal diseases should continue to be used as a basis for supporting emergency disease response and preparedness for disease emergencies in the region. Communication between fishery and veterinary authorities should be strengthened so that Asia's regional concerns can be more effectively communicated to OIE. Collaboration and communication among countries should be promoted to influence international standard setting and disease notification.

Regional technical support and existing technical support mechanisms (e.g. the Regional Advisory Group, regional resource centres) should be used to provide expert teams and information to countries to assist in responding quickly to disease problems. Further development of the regional technical support mechanisms under the NACA umbrella is recommended to support harmonization in diagnostics among countries and the upgrading of skills. Collaborative research should be encouraged to understand and respond to significant and emerging diseases in the region.

Early warning and early response

Effective implementation of early warning and early response system at the national level requires participation of personnel at three levels: the producers, the disease support center and the decision-making level. Important recommendations for each of thse levels include:

- At the producer level, (i) disseminating information on disease diagnosis (Level I); (ii) developing mechanisms for accessing and distributing disease information (including field guides in local languages) and having access to rapid field diagnostic tests, (iii) educating producers on methods of animal examination; (iv) developing a reporting culture among producers; (v) providing support for record keeping; (vi) supporting the development of farmer groups; (vii) providing increased advice on farm biosecurity, safe movement of live aquatic animals and their products; and (viii) providing guidance on methods for safe disposal and sanitation.
- At the disease support level, (i) increasing training and capacity building in diagnostics (Levels 2 & 3); (ii) increased epidemiological training; (iii) improving access to information; (iv) providing support for the establishment of laboratory information management systems; (v) encouraging a culture of disease investigation; and (vi) providing support for coordination between laboratories.

- At the decision-making level, (i) to continuously build awareness; (ii) to support development of practical surveillance systems with the flexibility to use different existing resources (e.g. those of the private sector and the livestock sector); (iii) conducting risk assessments on likely problems; (iv) to provide better description of emergency situations and "triggering" events; (v) to use systems analysis to provide clear descriptions of lines of authority, mandates and activities tuned to local conditions; and (vi) to develop mechanisms for financing.

Training
More work on human resource development is needed. Many training courses have been conducted in the region; however, technical training alone is not seen as sufficient. For example, specific training is needed on how to report scientific information for the purpose of early warning and early response.

Research
The region needs more needs-based, applied research. Research to support early warning should especially be targeted to three areas: pathology, microbiology (parasitology, virology, bacteriology, mycology) and epidemiology (including forecasting, risk assessment and assessment of the accuracy of Level 1 diagnosis). Collaborative research should be encouraged to understand and respond to significant and emerging diseases in the region.

Resources
The region needs resources to draw on in emergencies. Core funding should be allocated to regional organizations (e.g. NACA) to provide ready resources to respond rapidly to emergencies. For the less developed countries in the region (e.g. Cambodia, Laos, Bangladesh), lack of adequate human, institutional and financial resources is still the major constraint and thus training, capacity building and better infrastructure are urgently needed.

Communications
The profile of fish health and emergency preparedness needs to be raised to both the public and private sectors, highlighting the importance of emergencies from a socio-economic point of view. The role of "larger players" (geopolitical and supranational organizations and donor agencies) in addressing these issues needs to be strengthened.

Information transfer
Although there is a lot of knowledge about aquatic animal health in the world, the transfer of this knowledge to the Asian Region requires financial resources. Developed countries should invest on this issue because such knowledge is essential for the development of emergency preparedness systems.

Field exercises
Once countries have developed disease emergency contingency plans, staging field exercises for a simulated national disease emergency should be undertaken, as this will allow countries to test their contingency plans and see how their communication system works. Mock outbreaks (simulations) should be done at both the national and regional levels. These should involve various stakeholders such as the military, justice, finance, environment, agriculture etc.

Socio-economic impacts of disease epizootics
The investment of governments and the private sector in emergency preparedness and in aquatic animal health, in general, does not reflect the importance and value of the

aquaculture and fisheries resource. A desk study of the value of the aquatic resources in the different countries should be conducted, including an assessment of the magnitude of investment in the sector and the impact of disease. Such a study could be funded and undertaken by FAO and NACA.

Koi herpes virus outbreaks

Recent experience has shown that the systems in place in Indonesia and Japan to cope with disease emergencies were not effective against KHV infection. Detailed post-mortem analyses of the outbreaks of KHV in both countries should be conducted to determine why the respective governments were unable to contain the disease, the actions taken by government and private sector, the extent of their success, and the lessons learned.

It may be useful to have another workshop in a few years time to assess the progress made in Japan in establishing a system for early warning and preparedness.

Pilot projects on emerging diseases

Several emerging diseases are present in the region, and countries whose industries culture susceptible species should put in place some practical approaches. Pilot activities for key diseases such as abalone mortality, white tail disease etc. could be initiated by selecting a country to pilot a system for each disease. Each pilot system could involve people from the various countries most likely to be impacted by the disease and maybe also have people to visit different countries.

ANNEX 1

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ANNEX 2

Reports of the working groups

The following section briefly summarizes the discussions and conclusions arising from the three Working Group Meetings.

WORKING GROUP 1 – REGIONAL COOPERATION

Members: Elmo Weerakorn, Simon Funge-Smith, Michael Phillips, Hardjono, Nguyen Tu Cuong, Nguyen Xuan Ly, Doan van Dai, Kazuya Nagasawa, Ruhiyanto Haliman, Fachriyan H. Pasarien, Darnas Dana, Supranee Chinabut, Athula Seneviratna, Sena De Silva and Yoshiyuki Oketani

Objective – The objective of Working Group 1 was to identify needs and possible solutions related to improving regional cooperation to assist national efforts at emergency preparedness and response to outbreaks of serious aquatic animal diseases.

The Working Group recognized that while national agencies have the primary responsibility for responding to disease emergencies, regional cooperation can provide essential support. There is already collaboration in aquatic animal disease control in Asia that has helped in responding to emergency aquatic animal disease outbreaks. We should therefore build on these existing structures to strengthen cooperation to support national efforts to control serious aquatic animal disease outbreaks.

The Working Group then discussed the specific needs of the region with regards to improving international cooperation to address aquatic animal heath emergencies more effectively.

Regional reporting and communications – The Working Group noted that increased sharing of information on national aquatic animal disease status and emerging aquatic animal diseases of significance to Asia is required, and that the openness and accuracy of with which Asian nations provide this information needs to be improved. Awareness on methods for the control of aquatic animal diseases and emergency response should be increased. The Working Group noted that the NACA/FAO/OIE Regional Aquatic Animal Disease Reporting System is an important regional resource, and that the reporting system and the communication networks that support it at the national and regional levels should be further strengthened.

The Working Group noted the importance of the OIE in the setting of aquatic animal health reference standards for international trade, disease reporting and the disease control process. It also noted and that, for most Asian countries, the reporting of aquatic animal diseases to the OIE involves both the national fisheries and veterinary authorities. However, communication between Chief Veterinary Officers (CVOs) and senior fisheries officers within the OIE system is limited, and there are limited inputs from Asian countries to the standard setting process. Although the veterinary authorities have responsibility for official communication to OIE on livestock and aquatic animal diseases important for international trade, most veterinary authorities in Asia have limited experience with aquatic animal diseases. Thus communication between fishery and veterinary authorities should be strengthened so that Asia's regional concerns can be more effectively communicated to OIE. In this regard, national fisheries agencies need to be more proactive in developing the necessary linkages with their veterinary counterparts. Regional disease reporting is presently based on official quarterly reports. Countries should report more frequently on emergency diseases, to support rational decisions on emergency response measures.

The Working Group noted that the regional list of aquatic animal diseases – reviewed and developed annually by the Regional Advisory Group – includes both OIE-listed diseases and other diseases of emerging importance to the region. Such a list is useful and should continue to be used as a basis for supporting emergency disease response and preparedness for disease emergencies. The Regional Advisory Group should be strengthened through making formal recommendations to be passed through the veterinary channels to OIE.

Regional technical support – The Working Group considered that primary responsibility for prevention, preparedness and response to disease emergencies lies within each country. However, regional cooperation should be used to provide expert teams and information to countries to assist in responding quickly to disease problems. The Regional Advisory Group is a useful mechanism that can be more active in providing coordination and advice on recognizing emergencies and identifying the resources needed to respond effectively. Several competent regional institutions and resource centers exist to provide technical assistance (e.g. SEAFDEC-AQD, AAHRI) in disease emergencies. Collaboration between countries, particularly those countries sharing common borders and watersheds such as the Mekong Basin, on preventing the spread of aquatic animal diseases is also recommended for emergencies.

Diagnostic harmonization – The Working Work recognized that the sharing of information on significant aquatic animal diseases needs to be supported by better harmonization of disease diagnostic tests and techniques. Resource centers with specialist diagnostic skills are required to provide technical support to assist countries in dealing with aquatic animal disease problems. The further development of the resource centers and expert network under the NACA umbrella is recommended to support harmonization in diagnostics among countries and the upgrading of skills.

The Working Group recognized that the OIE code and diagnostic manual should be used as a reference in harmonizing diagnostic standards, and that care must be taken to ensure consistency with international standards. Collaboration and communication among countries should be promoted to influence international standard setting and disease notification. It is important for the region to be more active in getting information on aquatic animal diseases in the region into the OIE standards.

Research – Collaborative research should be encouraged to understand and respond to significant and emerging diseases in the region. The private sector must be involved, since they are also part of networks.

Resources – The Working Group agreed that the region needs resources to draw on in emergencies. Core funding should be allocated to NACA to provide ready resources to respond rapidly to emergencies; donor support should be sought.

Further regional cooperation – The Working Group recommended that joint activities between countries for testing of emergency response should be undertaken, and that regular meetings between countries and the exchange of expertise should be encouraged. Regional training on emergency preparedness is recommended. Regional centers to provide technical support to address emerging disease problems should be further developed.

WORKING GROUP 2 – EARLY WARNING

Members: Chris Baldock (Chairman), Agus Sunarto (Vice-chairperson), Flavio Corsin and C.V. Mohan (Rapporteurs), Celia R Lavilla-Pitogo, Phan Thi Van, Takaji Iida, Murdjani, Taukhid, Hambali Supriyadi , Ly Thi Thanh Loan, Viseth Hav, Thongphoun and Roar Gudding

Objective – The objective of Working Group 2 was to develop recommendations on what activities have to be carried out to implement early warning and detection of aquatic animal health problems and to identify the future steps to be taken at the national level.

Definition of emergency – The Working Group discussed the criteria that can be used to define an aquatic animal health emergency. The group agreed that the definition of emergency for producers and government may be different. For producers, an emergency would be a disease/syndrome (e.g. exotic disease, new disease) observed for the first time and/or any significant mortality/morbidity occurring in their system, including outbreaks of known diseases (e.g. EUS). From the perspective of a government, in addition to the above, emergencies would also include diseases having an impact on trade, human health or affecting the livelihood of poor communities. The Working Group recognized that although some diseases may not yet be considered emergencies, and thus might be ignored by decision makers, they may be recognized as emergencies in the future (e.g. white tail disease).

List of diseases for surveillance system – All the countries in the region have adopted the NACA/FAO/OIE regional disease list, which includes all diseases listed by OIE plus additional diseases of concern to the region. In addition, some countries have more comprehensive national disease lists that include pathogens/diseases of national concern.

Capacity requirements and delivery – A key point in the implementation of early warning systems is assessing the capacity requirements and how to deliver them. The following constraints were identified:

- Issues associated with the ability of field officers and other stakeholders to contribute to the flow of information (e.g. resources etc.); and
- Lack of staff, required skills, a system with the necessary flexibility, stakeholder motivation, and ability to confirm suspect outbreaks and their associated causes.

To alleviate the lack of field officers, farmer-group leaders and volunteer extension workers could be involved in the flow of information.

The Working Group identified three major levels at which capacity building is required: the producers, the disease support center and the decision-making level. Depending on the country, the latter two levels could be operating either at the provincial or national level. The responsibilities and the capacity required at the different levels for implementing an early warning system are identified in table 1.

Communication: warning system – The Working Group highlighted issues related to the slowness of information flow, which in some cases can take up to 1.5 months from emergency occurrence to response initiation. Of special concern is the fact that affected stock may be translocated in the time between emergency detection at the producer level and the initiation of a response, greatly increasing the risk of infectious disease spread. A potential solution to increase the speed of the warning system would be to limit the number of people/institutions involved in the information flow.

Web-based systems for disease reporting have been developed in some of the countries (e.g. Indofish), however, there are problems in populating databases. This is due to a number of constraints related to poor communication, including lack of lower level resources (e.g. at the level of producers, field officers etc.), internet culture, and strong leadership (people that can make it happen).

TABLE 1

Level	Responsibilities	Capacity Required
Producer	• recognize a disease emergency • report to the concerned authority	• ability to recognize an aquatic animal health problem • ability to recognize clinical signs (level 1 diagnosis) • ability to communicate the emergency to responsible authorities
Disease support center	• investigate emergencies • carry out targeted surveillance, when required • perform diagnostic tests (level 2 & 3) • ensure accuracy through a laboratory information management system • report to relevant authorities	• culture of disease investigation • capacity in diagnostics (Level 2&3) • expertise to establish lab information management systems • capacity to conduct surveillance
Decision making	• confirm disease emergencies & announce outbreaks • organize & coordinate surveillance systems & disease reporting for early warning • conduct risk analysis • develop national contingency plans for dealing with aquatic animal disease emergencies • communicate emergencies to relevant regional/international institutions	• awareness on significant health problems within the country & internationally • expertise in development of surveillance, risk analysis & other key areas

Encouraging producers to send information directly to the national level using modern communication tools (e.g. digital pictures, phone) is an approach that could be taken to overcome the slowness of the information flow and to make best use of the limited expertise available. The response from the national level could then be channeled to the producers through the local services (e.g. field officers, farmer groups). However, this approach may have limited application to the current Asian context.

The Working Group regarded the creation of regional awareness through the QAAD reporting system (e.g. for KHV) to be a part of an early warning system. This serves as an early warning for countries with susceptible species, so that they can take the necessary actions. It was recognized that regional awareness has the additional advantage of generating regional cooperation.

The Working Group identified possible tools for communicating emergencies at a wider level. These include Websites of regional organizations (e.g. NACA, SEAFDEC), aquafarmers' corner, on-line e-learning (which could involve a moderator), and mailing lists (e.g. Indonesian aquaculture mailing list for shrimp culture).

Motivation – The Working Group recognized that motivation at every level was a major concern. As the producers are normally the first to recognize an emergency, their motivation to report to the relevant authorities is essential to an early warning system. The Working Group discussed what would motivate producers to report and what can be done to promote motivation. The following issues were identified:

- building producers' trust in the field officers, who would need or have access to the knowledge required to help producers;
- creating awareness in producers on the risks faced when a disease emergency is not promptly reported;
- giving appropriate feedback on the problems reported and samples collected;
- providing solution to the problems – on this issue, the group expressed the concern that producers might stop reporting problems that cannot be solved;
- developing legislation to which the producers have to comply; and
- providing compensation (e.g. as in Japan).

Surveillance – The Working Group recognized that disease surveillance forms the basis for early warning and identified the following areas where improvements are necessary for the implementation of effective surveillance systems:

- better coordination at the national level;
- availability of adequate resources at every level;
- better problem definition and prioritization for using the often-limited resources;
- better management of laboratory information (e.g. sample tracking, validation); laboratory information management systems are well developed only in some countries;
- better diagnostic capability, with strong emphasis on better use of robust diagnostic techniques (e.g. pathology).

Enabling research – The Working Group recognized the importance of needs-based, applied research. Research to support early warning should especially be targeted to three areas: pathology, microbiology (parasitology, virology, bacteriology, mycology) and epidemiology (including forecasting, risk assessment and assessment of the accuracy of Level 1 diagnosis).

Legislation/notification-reporting – The Working Group recognized that legislation is an important support to the implementation of early warning (e.g. the Australian experience), although the existence of legislation, by itself, does not ensure the implementation of an effective system.

Regional/national planning and coordination – The Working Group recognized the need for awareness building at the national level on the importance of different levels of diagnosis (i.e. Levels 1, 2 and 3). This concern rises from the fact that Level 3 diagnosis is often perceived as sufficient. Another concern at the national level is the lack of awareness of diseases of aquatic animals by the livestock veterinary authority, which often hosts the OIE national delegate.

Interaction at the regional level was also recognized as essential to coordinate efforts, especially when countries share susceptible species. Issues such as the trade implications of reporting emergencies arise however, when a country considers whether or not to report an emergency associated with a non-OIE listed disease and ask for regional support.

PROBLEMS AND SOLUTIONS

For the purpose of identifying what needs to be done and the way forward, the group considered three disease emergency scenarios: (a) occurrence of an exotic disease, (b) outbreak of an unknown disease and (c) increased occurrence of a known endemic disease. Problems and solutions were identified at the producer, disease support and decision-making levels to support the implementation of an early warning system:

- **Producer level** – At the producer level, the major problems were identified as (i) poor ability to recognize the occurrence of a new or exotic disease, or to recognize a change in the magnitude of known disease; poor awareness of reporting protocol; and (iii) lack of motivation. Solutions suggested by the Working Group included (i) disseminating information on disease diagnosis (Level 1) and what to look at to identify problems; educating producers on methods of animal examination; (ii) developing a reporting culture among producers; (iii) providing support for record keeping; and (iv) supporting the development of farmer groups.
- **Disease support level** – At the disease support level, the Working Group identified problems due to (i) poor expertise in general pathology (inability to recognize new diseases) and disease diagnosis (Levels 2 & 3); (ii) inability of fish health workers to remain current with new diagnostic advancements; (iii) a general inadequacy in dedicated infrastructure and human resources in some countries (often with no obvious solution); (iv) poor awareness and/or motivation on the part of

fish health workers on the need to investigate all reports of disease outbreaks; (v) lack of active surveillance programmes; (vi) poor laboratory information management systems; and (vii) limited coordination between existing laboratories. The solutions identified included (i) increasing training and capacity building in diagnostics (Levels 2 & 3); (ii) improving access to information; (iii) providing support for the establishment of laboratory information management systems; (iv) encouraging a culture of disease investigation; and (v) providing support for coordination between laboratories.

- **Decision-making level** – At the decision-making level, the Working Group identified problems concerning (i) poor awareness of decision-makers on important issues (e.g. exotic disease), (ii) inadequate baseline data on diseases, (iii) lack of commitment in developing effective systems (e.g. quarantine, surveillance, risk analysis); (iv) slowness to report to the region and back to farmers; and (v) lack of motivation (in the case where a disease is already present). The solutions identified were (i) to continuously build awareness and (ii) to support development of practical surveillance systems with the flexibility to use different existing resources (e.g. those of the private sector and the livestock sector).

WORKING GROUP 3 – EARLY RESPONSE

Members: Dan Fegan (Chairman), Peter Beers (vice-chair), Mhd. Shariff and Richard Arthur (rapporteurs), Tore Hastein, Juan Albaladejo, Sarah Saleheen, Hasna Banu, Kamiso H. Nitimulyo, Arief Tasliihan, Doan Van Dai, Le Thi Hue Endang, Mudjintami and Dwika Herdikiawan .

Objective – The objective of Working Group 3 was to examine early response efforts both within and outside the region and develop recommendations on what activities have to be carried out to improve national capacity to mount timely and effective early responses to emergency disease situations.

After considerable discussion of individual country experiences, the Working Group considered the elements essential to mounting an effective early response to an emergency disease outbreak. These include:

- Authority to decide that an emergency response is required (may include pre-established criteria for identifying an emergency situation).
- Having a contingency plan in place. The plan should have been developed with the participation of all stakeholders, especially representatives from the farmers and industry. There is also a need to make new and/or emerging diseases reportable.
- Clear assignment/division of responsibilities. (For several countries, the issue of fisheries vs veterinary mandates and responsibilities has not been fully resolved. However, veterinarians have the authority to prescribe drugs in all countries.)
- Authority to place restrictions or enforce compliance on a farm or production facility (i.e. adequate legislation, enforcement and private-sector involvement).
- Access to adequate resources, including rapid access to funds needed to respond to an outbreak.
- Ability to develop an adequate case definition. (requires decisions on who is responsible for developing a national case definition and on how to access the necessary epidemiological expertise).
- Ability to define the extent of the problem and its pattern of spread.
- Ability to determine the costs vs benefits of potential interventions.
- Ability to implement movement restriction and determine the affected areas (feedback process).
- Capacity for adequate and effective communications, including publication of a case definition, internal communications, media relations, contacts with fish farmers etc.
- Presence of an established and effective disease reporting system.
- Access to adequate diagnostic capability
- Presence of an established education and extension system

The Working Group then considered in more detail some of the major requirements of effective early response to disease emergencies, the essential components and issues, the constraints, and the possible solutions.

Authority/responsibility – The essential components/issues for this major requirement were identified as (i) having defined responsibilities and lines of reporting, (ii) having an adequate case definition, (iii) being able to recognize an emergency situation (emergency recognition) and (iv) having adequate contingency planning to respond effectively to the emergency. The Working Group identified the following constraints: inadequate knowledge and training, unclear responsibilities, unclear chain of reporting, inadequate legislation and/or policy, inadequate private-sector cooperation, inadequate compensation and lack of donor support. The solutions were considered to be (i) better description of emergency situations and "triggering" events; (ii) use of systems analysis to provide clear descriptions of lines of authority, mandates and activities tuned to local conditions; (iii) effective implementation and coordination among agencies; and (v) assistance with contingency planning.

On-site investigation – The Working Group identified the essential components/issues for this major requirement as (i) trained local officers, (ii) expert backup, (iii) sample collection and (iv) farmer consultation. The main constraint noted was lack of resources. The solutions included increased epidemiological training, development of mechanisms for financing (local and international), development of effective animal health links (e.g. between fisheries departments and veterinary services), conducting risk assessments on likely problems; developing mechanisms for accessing and distributing disease information (including field guides in local languages) and having access to rapid field diagnostic tests.

Laboratory support – The Working Group identified the essential components/issues for this major requirement as (i) access to adequate resources, (ii) presence of an effective sample submission system, and (iii) the presence of adequate regional and national support. Lack of resources (human, infrastructure, financial etc.) was considered the main impediment, while potential solutions included increasing the availability of tests, developing rapid field diagnostic tests, developing collection and handling protocols, and developing laboratory accession and reporting systems.

Quarantine/movement restrictions – The Working Group identified the essential components/issues for this major requirement as (i) adequate biosecurity (water, vectors, stock); (ii) adequate and safe sanitation and disposal; (iii) appropriate and safe chemical usage; and (v) adequate supporting legislation. The primary constraints were seen as a lack of expertise and resources. Solutions included providing increased advice on farm biosecurity; developing local procedures; providing practical advice on safe movement of live aquatic animals and their products, on chemical usage, and on methods for safe disposal and sanitation; and developing GIS support systems for farm, geographical and trade mapping.

Epidemiological investigations – The Working Group identified the essential components/issues for this major requirement as (i) need to be able to trace disease outbreaks both forward and backward; (ii) to determine the extent of problem and its spread; and (iii) to have adequate record-keeping (both on and off site), coordination and data analysis. Lack of expertise and resources were identified as main constraints, while providing training in epidemiology and emergency management, and developing information management systems were seen as potential solutions.

Communications – The Working Group identified the essential components/issues for this major requirement as (i) having adequate local communication, including feed back; (ii) having adequate communication at the national level; (iii) dealing effectively with the media; (iv) developing effective reporting systems for communicating with stakeholders and (v) having mechanisms to provide regular updates of the disease emergency situation. The major constraint identified was a lack of experienced people to deal with media, while increasing the availability of information on biosecurity practices, providing media training and developing information reporting systems were seen as possible solutions.

Moving on (post-emergency actions) – The working group identified the essential components/issues for this major requirement as (i) making good decisions on control of movements of aquatic animals and/or zoning; (ii) conducting enabling research (including developing vaccines for major pathogens); and (iv) providing advice. The major constraints were identified as lack of expertise and resources, while the possible solutions included improving research infrastructure, developing and improving information dissemination systems, and developing zoning plans (including monitoring and surveillance programmes).

Post-mortem/cost-benefit analysis – The Working Group identified the essential components/issues for this major requirement as (i) learning from the experience, and (ii) providing feedback and improvement to stakeholders. The major constraints were identified as lack of expertise and resources, while obtaining access to cost/benefits expertise was seen as a solution.

Contributed papers

A historical overview of pathogen introductions and their transboundary spread in Asia

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Arthur, J.R.. A historical overview of pathogen introductions and their transboundary spread in Asia. p. 21–39. In: Subasinghe, R.P.; Arthur, J.R. (eds.). Regional workshop on preparedness and response to aquatic animal health emergencies in Asia. Jakarta, Indonesia, 21–23 September 2004. *FAO Fisheries Proceedings*. No. 4. Rome, FAO. 2005. 178p.

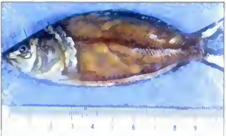
ABSTRACT

This paper briefly reviews the history of some of the major transboundary aquatic animal diseases in the Asia-Pacific Region and summarizes the status of some of the major diseases currently affecting the region (primarily those diseases listed by the Office International des Épizooties (OIE) or included in the Network of Aquaculture Centres in Asia-Pacific (NACA)/Food and Agriculture Organization of the United Nations (FAO)/OIE Quarterly Aquatic Animal Disease Reporting System). Emphasis is placed on those diseases having wide distributions and impacts in the region, with less attention paid to diseases of cold-water species such as salmonids, and those of very limited distribution. Some emerging diseases that could have significant impacts on aquaculture in the region in the near future are also discussed.

INTRODUCTION

Although parasites and pathogens are common in wild populations of aquatic animals, reports of serious disease outbreaks and associated mass mortalities in wild stocks due to their normal pathogen fauna are rare. This is because in natural systems the pathogen and the host have generally had a long period of time to adapt to each other, the pathogen often becoming less pathogenic and the host more tolerant of, or resistant to infection.

Serious epizootics of fish, shellfish and molluscs appear to be primarily a modern phenomenon, and are often associated with the intensification of aquaculture, where many animals are confined at high density and under conditions that are often stressful. Such conditions are often optimal for disease transmission, and organisms that are not a serious problem to the host species in the wild may become highly pathogenic. The international movement of aquatic animals for aquaculture purposes, while not entirely a recent development, has accelerated considerably during the past 50 years (see Arthur, 2004; Subasinghe and Bartley, 2004). As a result, exotic pathogens have been moved far outside their natural ranges, where they have gained exposure to new and naive host populations. Thus the vast majority of serious disease outbreaks that have occurred in the past 50 years are either known or believed to have been caused by transboundary aquatic animal pathogens (TAAPs) – exotic pathogens that have been transported between countries and regions into new geographic areas where they have flourished. Their economic impacts on aquaculture are well documented and include



H YOKOYAMA

Myxobolus artus *infection in the skeletal muscle of 0+ carp*

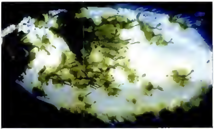
direct losses to production and secondary industries, as well as socio-economic hardships on communities (see Bondad-Reantaso, 2004). Impacts of TAAPs on wild populations of aquatic animals are less well-documented; but in at least one case, epizootic ulcerative syndrome (EUS) of freshwater fish, are thought to be considerable (Lilley, Callinan and Khan, 2002; Das, 2002).

This paper briefly reviews the history of some of the major transboundary aquatic animal diseases in the Asia-Pacific Region and summarizes the status of some of the major diseases currently affecting the region (primarily those diseases listed by the Organisation mondiale de la santé animale (OIE) or included in the Network of Aquaculture Centres in Asia-Pacific (NACA)/Food and Agriculture Organization of the United Nations (FAO)/OIE Quarterly Aquatic Animal Disease Reporting System). Emphasis is placed on those diseases having wide distributions and impacts in the region, with less attention paid to diseases of cold-water species such as salmonids, and those of very limited distribution. Some emerging diseases that could have significant impacts on aquaculture in the region in the near future are also discussed.

HISTORICAL ACCOUNTS

Ichthyophthiriasis hits Java

The first recorded disease epizootic in Asia thought to be due to an introduced pathogen was an outbreak of ichthyophthiriasis or "white spot disease" of freshwater fish that occurred on the island of Java, Indonesia in 1932 (see Buschkiel, 1935; Sachlan, 1952; Djajadiredja *et al.*, 1983; Arthur, 1996). The outbreak was reported by Alfred L. Buschkiel (Buschkiel 1935), a German scientist who worked at the Laboratorium voor de Binnenvisscherij in Buitenzorg (now Bogor) during the early 1930s. He reported that ichthyophthiriasis, due to the pathogenic ciliate *Ichthyophthirius multifiliis*, was particularly prevalent at the eastern border of West Java and that it spread rapidly eastward to Central Java with the transport of infected fish. Java barb *(Barbonymus gonionotus)*, kissing gourami *(Helostoma temmincki)*, common carp (*Cyprinus carpio*) and giant gourami (*Osphronemus goramy*) were the species most severely affected. The outbreak was associated with a very long drought that allowed the parasite to develop unchecked in the rather heavily stocked ponds. Although Sachlan (1952) noted that the parasite was first encountered in an aquarium at Bogor in 1928 and was probably introduced with ornamental fish from the United States and Europe, he also stated that many cases had been previously reported from Java and Sumatra. Measures taken to prevent the spread of the disease, which included ordering pond owners to drain infected ponds immediately and prohibiting the sale of infected fish, were ineffective. Losses due to the white spot epidemic in Indonesia were estimated at some 10 000 Dutch guilders, an amount that exceeded losses of salmonids in European countries caused by similar outbreaks between 1919-1928 (see Buschkiel, 1935; Sachlan, 1952).



J R ARTHUR

Surface parasites, Lerneae cyprinacea *infection of giant gouramy*

Wild mullet in Philippines (1989) with EUS

M.G. BONDAD-REANTASO

Myobolus and Lernaea problems in Indonesia

In 1951, another pathogen, tentatively identified as *Myxobolus pyriformis*, was reported to have killed thousands of Java barb fry in a government hatchery in Central Java (Sachlan 1952). Djajadiredja *et al.* (1983), who considered this myxosporean to have probably been introduced to Indonesia, reported in 1982 that this gill parasite had caused serious losses annually. These authors also noted that two other unidentified species of *Myxobolus*, suspected to have been introduced to Indonesia from Japan, have caused considerable losses (mortalities of 60-90 percent) of common carp fingerlings in Java since 1974.

Anchor worm (*Lernaea cyprinacea*) is a parasitic copepod that was introduced into Indonesia from Japan 1953 (Djajadiredja *et al.*, 1983). The parasite caused a serious epizootic in economically important species such as common carp, Java barb, kissing gourami and giant gourami, and quickly spread to other regions of the country. Losses were quite significant, with about 30 percent of hatchery production in the main hatchery centers of Java, northern Sumatra and northern Sulawesi affected. In Java, it was estimated that some 1.48 billion fry were lost, worth some 7.4 billion rupiahs (approximately US$11.4 million).

Epizootic ulcerative syndrome – a disease impacts wild fish stocks

Epizootic ulcerative syndrome (EUS) is a fungal-caused disease that has affected cultured and wild fresh and brackish-water fish species throughout much of the Asia-Pacific. It is now endemic in Southeast and South Asia and has recently expanded its range into West Asia (see FAO, 2001).

EUS is indistinguishable from mycotic granulomatosis of Japan, which was first recorded in 1971, red spot disease of eastern Australia, reported in 1972, and the ulcerative mycosis disease affecting Atlantic menhaden in the United States since 1978. Although more than 100 species of fish have been reported to be affected (see Chinabut & Roberts, 1999; Lilley, Phillips and Tonguthai, 1992), populations of some species are much more severely impacted than others.

Some idea of the impacts of EUS on the relative abundances of wild fish is given by Das (1994), who studied the landings at the Jorhat Fish Assembly Centre in Assam for species of EUS-affected fish from the capture fishery in the Brahmaputra River system before (1987–1988) and during the initial (1988–1991) three years in which outbreaks

Ayu, Plecoglatus altivelis, *infected with mycotic granulomatosis*

K. HATAI

TABLE 1
Impact of EUS on local abundance of highly susceptible species (modified from Das 1994)

Species	Decline in Landings (%)
Channa punctata	85–94%
C. striata	82–88%
Nandus nandus	82–97%
Puntius spp	64–90%
Amblypharyngodon mola	37–71%
Labeo rohita	49–63%
L. bata	54–87%
Cirrhinus cirrhosus	28–66%

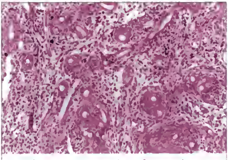
occurred in India (see Table 1). His data showed declines in catches of highly susceptible species by as much as 97 percent. Among the species most severely affected were snakeheads (Channidae – *Channa punctata*, *C. striata*) and native cyprinids (*Puntius* spp., *Labeo rohita*, *L. bata* and *Cirrhinus cirrhosus*).

THE DISTRIBUTION OF SERIOUS TRANSBOUNDARY DISEASES IN THE ASIA-PACIFIC REGION

The geographic distributions of the major serious transboundary diseases affecting finfish, crustaceans and molluscs in the Asia-Pacific Region (excluding West Asia) are presented in Tables 2–4. The information given in these tables is drawn mainly from the International Database on Aquatic Animal Diseases (www.collabcen.net/toWeb/aq2.asp) and the NACA/FAO Quarterly Aquatic Animal Disease Reports (Asia and Pacific Region) (www.enaca.org/Health/QAAD), which summarize data submitted by the national authorities of participating countries to the NACA/FAO/OIE Quarterly Aquatic Animal Disease (QAAD) Reporting System. These tables represent a "best guess" as to the distribution of the various pathogens, and do not include a number of reports for countries such as India, Laos, Malaysia and Myanmar that are considered to be erroneous or highly suspect.

A number of the diseases of finfish listed by the OIE affect only Salmonidae or other cold or temperate-water fishes and thus have existing or potential ranges in the Asia-Pacific that are limited to countries having temperate climates, such as Japan, the Republic of Korea, northern China, southern Australia and New Zealand. These include infectious haematopoietic necrosis (IHN), viral haemorrhagic septicaemia (VHS), *Oncorhynchus masou* virus disease (OMVD), infectious pancreatic necrosis (IPN), bacterial kidney disease (BKD), epizootic haematopoietic necrosis (EHN) and red seabream iridoviral disease (RSBID). Although not reported from South Asia, those diseases affecting salmonids could potentially occur in a few mountainous regions of India, Sri Lanka and Nepal where trout (primarily rainbow trout, *Oncorhynchus mykiss*) have been introduced to support limited sport fisheries. However, any impacts in these areas would be quite localized.

Several of the OIE-listed diseases that are widespread across the Asia-Pacific Region have been present in the region for more than a decade. These include EUS of fresh and brackish-water fishes, viral encephalopathy and retinopathy (VER) of marine fishes, and white spot disease (WSD), yellowhead disease (YHD) and Penaeus monodon baculovirosis (PMV) of marine shrimp. Some diseases, such as VER, have probably always occurred throughout much on the region in wild populations of aquatic organisms but have only been reported to cause disease problems when their hosts have begun to be raised in aquaculture facilities. Two other diseases recently added to the OIE list that are poorly studied in Asia-Pacific, enteric septicaemia of catfish (ESC) and grouper iridoviral disease (GID), may also fall into this category. Other diseases, such as WSD, YHD and PMV probably


Typical severe mycotic granulomas from muscle section of EUS fish (H & E)

M G BONDAD REANTASO

TABLE 2

Historical data on the occurrence of serious transboundary diseases of finfish in the Asia-Pacific Region.[1] (+=reported,?=suspected, [?]=report of uncertain status (primary sources: www.colabcen.net/toWeb/aq2.asp; www.oie-jp.org); www.enaca.org/Health/QAAD; FAO 2001

	OIE-listed Diseases[1]											Other Diseases Monitored		
Country	EHN	IHN	SVC	OMVD	VHS	VER	IPN	EUS	BKD	RSBID	ESC	KHV	Epi	GID
East Asia														
China P.R		+	+			+	+			?		+		?
Japan		+		+	+	+	+	+	+	+		+		
Taipei China		+				+	+			?		+		+
Hong Kong China						+				+		+	+	+
Korea Rep.		+	?		+	+	+			+		?		
Southeast Asia														
Cambodia								+						
Indonesia						+		+			+	+		+
Laos[2]								+						
Malaysia[2]						+		+		+		+		+
Myanmar[2]								+						
Philippines						+		+						
Singapore						+		+						+
Thailand						+	[?]	+		+[?]	+		+	+
Viet Nam						+		+			+			+
South Asia														
Bangladesh								+						
India[2]								+						
Nepal								+						
Sri Lanka								+						
Australia/South Pacific														
Australia	+					+		+			+			
French Polynesia						+								
New Caledonia														
New Zealand							+							

[1] EHN=epizootic haematopoietic necrosis, IHN=infectious haematopoietic necrosis, SVC=spring viraemia of carp, OMVD=Oncorhynchus masou virus disease, VHS=viral haemorrhagic septicaemia, VER=viral encephalopathy and retinopathy, IPN=infectious pancreatic necrosis, EUS=epizootic ulcerative syndrome, BKD=bacterial kidney disease, RSBID=red sea bream iridoviral disease, ESC=enteric septicaemia of catfish, KHV=koi herpesvirus, Epi=eptheliocystis, GID= grouper iridoviral disease.

[2] A number of positive or suspected disease reports for these countries were corrected in subsequent country reports to OIE

TABLE 3

Historical data on the occurrence of serious transboundary diseases of crustaceans in the Asia-Pacific Region.[1] (+=reported, ?=suspected, [?]=report of uncertain status) (primary sources: www.coiabcen.net/toWeb/aq2.asp; www.oie-jp.org; www.enaca.org/Health/QAAD; FAO 2001

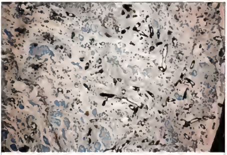
	OIE-listed Diseases								Other Diseases Monitored
Country	IHHN	TS	WSD	SB (PMB)	TB (BP)	YHD/GAV	SMVD	NHP	BVMGN
East Asia									
China PR		+	+			+			
Japan			+						+
Taipei China	+	+	+	+		+			
Hong Kong China			+						
Korea Rep			+						[?]
Southeast Asia									
Cambodia									
Indonesia	+	+	+			+			?
Laos									
Malaysia	+	?	+	+	[?]	+			
Myanmar	+		+						
Philippines	+		+	+		+	+		[?]
Singapore	+		+	+					
Thailand	+	+	+	+		+			
Viet Nam	?	+	+	+		+			
South Asia									
Bangladesh			+			+			
India	+		+	+		+	[?]		
Nepal									
Sri Lanka			+			+	+		
Australia/South Pacific									
Australia	+			+		+(GAV)	+		?
French Polynesia	+								
New Caledonia	+								
New Zealand									

[1] IHHNV-infectious hypodermal and haematopoietic necrosis, TS=Taura syndrome, WSD=whitespot disease, SB (PMB)=spherical baculovirosis (Penaeus monodon-type baculovirus), TB(BP)=tetrahedral baculovirosis (Baculovirus penaei), YHD/GAV=yellow head disease/gill- associated virus, SMVD=spawner-isolated mortality virus disease, NHP=necrotising hepatopancreatitis, BVMGN=baculoviral midgut gland necrosis.

TABLE 4

Historical data on the occurrence of serious transboundary diseases of molluscs in the Asia-Pacific Region. (+=reported) (primary sources: www.colabcen.net/toWeb/aq2.asp; www.oie-jp.org; www.enaca.org/Health/QAAD; FAO 2001)

	OIE-listed Diseases					Other Diseases Monitored		
Country	***Bonamia exitiosa***	***Marteilia sydneyi***	***Mikrocytos roughleyi***	***Perkinsis olseni/atlanticus***	***Haplosporidium nelsoni***	***Marteilioides chungmuensis***	**Akoya Oyster Disease**	**Abalone Mortality Virus**
East Asia								
China PR								
Japan					+	+	+	
Taipei China								
Hong Kong China								
Korea Rep.				+	+	+		
Southeast Asia								
Cambodia								
Indonesia								
Laos								
Malaysia								
Myanmar								
Philippines								
Singapore								
Thailand								
Viet Nam								
South Asia								
Bangladesh								
India								
Nepal								
Sri Lanka								
Australia/South Pacific								
Australia		+	+	+				
French Polynesia								
New Caledonia								
New Zealand	+			+				



M G BONDAD REANTASO

Mycotic granulomas showing fungal hyphae (stained black) using Grocotts stain

originated within the Asia-Pacific and were thus initially of very limited geographic distribution. However, they have now become widely distributed through the movement of infected hosts for aquaculture development. These diseases are now probably endemic in wild populations of aquatic animals throughout much of the region. In many cases, the problem that governments now face is not "How do we prevent the entry of these pathogens into our national territory?", but rather "How do we prevent their spread to those areas of the country that are still uninfected?", and "What can we do to prevent their introduction into individual aquaculture facilities, or to manage or eradicate these diseases in infected facilities?"

A few diseases, particularly some of those affecting marine shrimp (Penaeidae) are truly exotic to the Asia-Pacific, having recently been translocated into the region along with the introduction of infected exotic shrimp species, primarily white shrimp (*Litopenaeus vannamei*) and blue shrimp (*L. stylirostris*). These include infectious hypodermal and haematopoietic necrosis (IHHN), which has now widely distributed in Southeast Asia and the South Pacific, but apparently not in South Asia, and Taura syndrome (TS), which has recently been recorded from several East and Southeast Asian countries.

Unfortunately, the distribution of serious transboundary diseases in some countries in some parts of the Asia-Pacific Region remains unclear due to limited capacity for disease diagnosis, an absence of disease surveillance and monitoring programmes, and/or problems with accurate disease reporting. This is particularly true for diseases of molluscs throughout much of Asia, and for diseases of finfishes in developing countries such as Cambodia, Laos, Myanmar, Bangladesh, Nepal etc. In some countries, an additional problem is the apparent lack of awareness by the veterinary and/or fisheries authorities as to their country's national disease status. Thus in some cases, recent reports to NACA/FAO/OIE for some countries indicate that a given disease is either "never reported" or that there is "no information available" when reports of disease occurrence exist, either in the official reports to OIE, or elsewhere in the scientific literature.

THE CURRENT TRANSBOUNDARY DISEASE SITUATION IN THE ASIA-PACIFIC REGION

Tables 5–7 present summaries of the diseases listed or monitored by the NACA/FAO/OIE QAAD Reporting System for Asia-Pacific for the period 1 July 2003 – 31 June 2004, and include the most recent data available. It should be noted that these tables list only the reports of disease occurrence, and typically do not provide any indication of the seriousness or magnitude of the outbreaks. Nevertheless, the fact that a disease has recently been reported to occur in many countries gives some indication that the disease may still be a major problem in the region.

A number of serious diseases of finfish that are widely distributed in the Asia-Pacific were reported during the 12 months for which data are available. Viral encephalopathy and retinopathy (VER) of marine fish (groupers, seabass etc.) was reported from East Asia (Japan, Hong Kong and Taipei), Southeast Asia (Indonesia (?), Philippines, Thailand and Viet Nam), Australia and the South Pacific (French Polynesia), while epizootic ulcerative syndrome (EUS) was recorded from Southeast Asia (Cambodia,

TABLE 5

Summary of reports of the occurrence of serious transboundary diseases of finfish in the Asia-Pacific Region, July 2003–June 2004. (+ = reported or known to be present during period; +? = serological evidence and/or isolation of causative agent but not clinical disease; ? = suspected but presence not confirmed; +( ) = occurrence limited to certain zones; * = no information available; 0000 = never reported; - = not reported during period but disease is known to occur (Data for countries reporting to the NACA/FAO/OIE Regional Quarterly Aquatic Animal Disease (QAAD) Reporting System are taken from the FAO/NACA Quarterly Aquatic Animal Disease Reports (www.enaca.org/Health/QAAD); that for other countries (Taipei China, French Polynesia, New Caledonia and New Zealand) are taken from OIE (www.oie-jp.org)**

	OIE-listed Diseases[1]											Other Diseases Monitored		
Country	EHN	IHN	SVC	OMVD	VHS	VER	IPN	EUS	BKD	RSBID	ESC	KHV	Epi	GID
East Asia														
China PR	0000	-	***	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000	0000
Japan	0000	+	0000	+	+	+	+	-	+	+	0000	+	+	0000
Taipei China	***	***	***	***	***	+	***	0000	***	0000	0000	-	***	-
Hong Kong China	0000	0000	0000	0000	000	+	0000	0000	0000	+	0000	0000	+? (-)	+
Korea, Rep	0000	-	?	0000	-	-	-	0000	0000	+		-		
Southeast Asia														
Cambodia	***	***	***	***	***	***	***	+	***	***	***	***	***	***
Indonesia	***	***	***	***	***	0000 [?][2]	0000	***	0000	0000	0000	+	0000	+( )
Laos	***	***	***	***	***	***	***	***	***	***	***	***	***	***
Malaysia	0000	0000	0000	***	0000	-	***	-	0000	0000	***	0000	***	-
Myanmar	0000	0000	0000	0000	0000	0000	0000	-	0000	0000	0000			
Philippines	0000	0000	0000	0000	0000	+	0000	-	0000	0000	***	0000	***	***
Singapore	0000	0000	0000	0000	0000	-	0000	0000	0000	0000	0000	0000	-	-
Thailand	0000	0000	0000	0000	0000	+	-	+	***	0000	***	0000	0000	0000
Viet Nam	0000	0000	0000	0000	0000	+	0000	+( )	0000	0000	0000			+
South Asia														
Bangladesh	***	***	***	***	***	***	***	+	***	***	***	***	***	***
India	0000	0000		0000	0000		0000	-	0000	0000				
Nepal	***	***	***	***	***	***	***	+	***	***	***	***	***	***
Sri Lanka	0000	0000	0000	0000	0000	0000	0000	?	0000	0000	0000	0000	0000	0000
Australia/South Pacific														
Australia	+	0000	0000	0000	0000	+	0000	+	0000	0000	-	***	***	***
French Polynesia	***	***	***	***	***	+( )	***	***	***	***	***			
New Caledonia	***	***	***	***	***	***	***	***	***	***	***	***	***	***
New Zealand	0000	0000	0000	0000	0000	0000	+?	0000	0000	0000	0000	0000	+	0000

[1] EHN=epizootic haematopoietic necrosis, IHN=infectious haematopoietic necrosis, SVC=spring viraemia of carp, OMVD=Oncorhynchus masou virus disease, VHS=viral haemorrhagic septicaemia, VER=viral encephalopathy and retinopathy, IPN=infectious pancreatic necrosis, EUS=epizootic ulcerative syndrome, BKD=bacterial kidney disease, RSBID=red sea bream iridoviral disease, ESC=enteric septicaemia of catfish, KHV=koi herpesvirus, Epi=eptheliocystis, GIV= grouper iridoviral disease.

[2] Disease was reported as present in reports for July-Sept, Oct.-Dec. 2003, but indicated as "never reported" in subsequent reports.

TABLE 6

Summary of reports of the occurrence of serious transboundary diseases of crustaceans in the Asia-Pacific Region, July 2003–June 2004. (+ = reported or known to be present during period; +? = serological evidence and/or isolation of causative agent but not clinical diseases; ? = suspected but presence not confirmed; +( ) = occurrence limited to certain zones; * = no information available; 0000 = never reported; - = not reported during period but disease is known to occur (Data for countries reporting to the NACA/FAO/OIE Regional Quarterly Aquatic Animal Disease (QAAD) Reporting System are taken from the FAO/NACA Quarterly Aquatic Animal Disease Reports (www.enaca.org/Health/QAAD), that for other countries (Taipei China, French Polynesia, New Caledonia and New Zealand) is taken from OIE (www.oie-jp.org)**

	OIE-listed Diseases[1]								Other Diseases Monitored
Country	**TS**	**WSD**	**YHD/GAV**	**SB (PMB)**	**IHHN**	**SMVO**	**TB (BP)**	**NHP**	**BVMGN**
East Asia									
China PR	+( )	+	0000	0000	0000	0000	0000	0000	0000
Japan	0000	+	0000	0000	0000	0000	0000	0000	0000
Taipei China	-	-	***	***	0000	***	***	***	***
Hong Kong China	0000	+?	0000	0000	0000	0000	0000	0000	0000
Korea Rep.	0000	-	0000		0000	0000			
Southeast Asia									
Cambodia	***	***	***	***	***	***	***	***	***
Indonesia	+	+	0000	0000	0000	0000	0000	0000	0000
Laos	***	***	***	***	***	***	***	***	***
Malaysia	?	+( )	-	-	-	0000	- [?]	0000	
Myanmar	0000	+( )	0000	0000	+( )	0000	0000	0000	
Philippines	0000	+	***	***	***	-	***	***	***
Singapore	***	-	***	-	***	***	***	***	***
Thailand	+	+	+	?	+	***	***	***	***
Viet Nam	+( )	+	+	+	?	0000	0000	0000	
South Asia									
Bangladesh	***	+	***	***	***	***	***	***	***
India	***	+( )	***		***	0000			
Nepal	***	***	***	***	***	***	***	***	***
Sri Lanka	0000	+	?	0000	0000	0000	0000	0000	0000
Australia/South Pacific									
Australia	0000	0000	+	-	+?	-(?)	0000	0000	0000
French Polynesia	***	***	***	***	***	***	***	***	
New Caledonia	0000	0000	0000	0000	+	0000	0000	0000	0000
New Zealand	0000	0000	0000	0000	0000	0000	0000	0000	0000

[1] TS=Taura syndrome, WSD=whitespot disease, YHD/GAV=yellow head disease/gill-associated virus, SB (PMB)=spherical baculovirosis (Penaeus monodon-type baculovirus), IHHN=infectious hypodermal and haematopoietic necrosis, SMVD=spawner-isolated mortality virus disease, TB (BP)=tetrahedral baculovirosis (Baculovirus penaei), NHP=necrotising hepatopancreatitis, BVMGN=baculoviral midgut gland necrosis.

TABLE 7.

Summary of reports of the occurrence of serious transboundary diseases of finfish in the Asia-Pacific Region, July 2003–June 2004. (+ = reported or known to be present during period; +? = serological evidence and/or isolation of causative agent but not clinical diseases; ? = suspected but presence not confirmed; +( ) = occurrence limited to certain zones; * = no information available; 0000 = never reported; - = not reported during period but disease is known to occur (Data for countries reporting to the NACA/FAO/OIE Regional Quarterly Aquatic Animal Disease (QAAD) Reporting System are taken from the FAO/NACA Quarterly Aquatic Animal Disease Reports (www.enaca.org/Health/QAAD), that for other countries (Taipei China, French Polynesia, New Caledonia and New Zealand) is taken from OIE (www.oie-jp.org)**

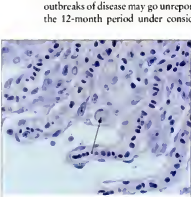
	OIE-listed Diseases					Other Diseases Monitored		
Country	**Bonamia exitiosa**	**Marteilia sydneyi**	**Mikrocytos roughleyi**	**Perkinsis olseni/ atlanticus**	**Haplosporidium nelsoni**	**Marteilioides chungmuensis**	**Akoya Oyster Disease**	**Abalone Mortality Virus**
East Asia								
China PR	0000	0000	0000	0000	0000	0000	0000	0000
Japan	0000	0000	0000	0000	-	+	+	0000
Taipei China	***	***	***	***	***	***	***	***
Hong Kong China	0000	0000	0000	0000	0000	0000	0000	0000
Korea Rep.	0000	0000	0000	+	0000	+	0000	
Southeast Asia								
Cambodia	***	***	***	***	***	***	***	***
Indonesia	0000	0000	0000	0000	0000	0000	0000	0000
Laos	***	***	***	***	***	***	***	***
Malaysia	0000	0000	0000	0000	0000	0000	0000	0000
Myanmar	***	***	***	***	***	***	***	***
Philippines	0000	0000	0000	0000	0000	0000	0000	0000
Singapore	***	***	***	***	***	***	***	***
Thailand	***	***	***	***	***	***	***	***
Viet Nam	0000	0000	0000	0000	0000	0000	0000	0000
South Asia								
Bangladesh	***	***	***	***	***	***	***	***
India	0000	0000	0000	0000	0000			
Nepal	0000	0000	0000	0000	0000	0000	0000	0000
Sri Lanka	0000	0000	0000	0000	0000	0000	0000	0000
Australia/South Pacific								
Australia	0000	+	+	+	0000	***	0000	***
French Polynesia	0000	0000	0000	0000	0000	0000	0000	***
New Caledonia	0000	0000	0000	0000	0000	0000	***	***
New Zealand	+( )	0000	0000	+( )	0000	0000	0000	0000

Thailand and Viet Nam), South Asia (Bangladesh, Nepal and Sri Lanka) and Australia. Red seabream iridovirus disease (RSBID) was reported from three countries in East Asia (Japan, Hong Kong and the Republic of Korea). Several diseases of salmonids continue to be reported from East Asia (primarily Japan). These include IHN, OMVD, VHS, IPN and BKD. Epitheliocystis was reported from East Asia (Japan and Republic of Korea) and New Zealand, while epizootic haematopoietic necrosis (EHN) was detected in redfin perch (*Perca fluviatilis*) following a fish kill in Australia. Two finfish diseases, Koi herpes virus (KHV) and grouper iridoviral disease (GID), appear to be spreading in the Asia-Pacific Region and thus will be discussed in detail later. Although the occurrence of spring viraemia of carp (SVC) in the Asia-Pacific Region has not yet been officially reported to the NACA/FAO/OIE Quarterly Aquatic Animal Disease Reporting System, the virus has recently been isolated from koi and common carp in China P.R (see the International Database on Aquatic Animal Diseases, www.collabcen.net/toWeb/aq2.asp). One other disease, enteric septicaemia of catfish (ESC), was not reported during the period in question

Several diseases of Crustacea were widely reported from the Asia-Pacific during the most recent 12 months of reporting to NACA/FAO/OIE. Whitespot disease (WSD) continues to plague shrimp production in much of East Asia (China P.R., Japan and Hong Kong), Southeast Asia (Indonesia, Malaysia, Myanmar, Philippines, Thailand and Viet Nam) and South Asia (Bangladesh, India and Sri Lanka). Yellowhead disease (YHD) was recorded from Southeast Asia (Thailand and Viet Nam) and South Asia (Sri Lanka), while the closely related gill-associated virus (GAV) was reported from Australia. Infectious hypodermal and haematopoietic necrosis (IHHN) was reported from Southeast Asia (Myanmar, Thailand and Viet Nam), Australia and the South Pacific (New Caledonia), while spherical baculovirosis (SB) was recorded from Southeast Asia (Thailand and Viet Nam). One exotic viral disease of penaeid shrimp (Taura syndrome, TS) is an emerging disease in Asia, and will be discussed in more detail later. Other diseases listed by NACA/FAO/OIE were either not reported during the period in question (spawner-isolated mortality virus disease, SMVD) and baculoviral midgut gland necrosis, BVMGN) or have never been confirmed or reported from the region (tetrahedral baculovirosis, TB, and necrotising hepatopancreatitis, NHP).

As previously mentioned, the ability of the majority of countries reporting to NACA/FAO/OIE to diagnose diseases of molluscs is very limited and thus the occurrence of outbreaks of disease may go unreported, particularly in South and Southeast Asia. During the 12-month period under consideration, Japan reported cases of *Marteilioides* and Akoya oyster disease, while the Republic of Korea reported cases of *Marteilioides* and *Perkinsis*. Australia reported cases of *Marteilia*, *Mikrocytos* and *Perkinsis*, and New Zealand reported cases of *Bonamia* and *Perkinsis*. Two molluscan diseases may be emerging in the region (Akoya oyster disease and abalone mortality virus) and thus will be discussed in more detail below.

Information on the seriousness of the disease outbreaks that occurred in the Asia-Pacific Region during the past 12 months and their social and economic impacts is generally lacking. The impacts of Koi herpes virus on koi and common carp culture in Indonesia and Japan are briefly mentioned below, and are presented in more detail elsewhere (Iida *et al.*, 2004; Sano *et al.*, 2004; Sunarto *et al.*, 2004).



R. HEDRICK, UC DAVIS

KHV pathology. Hyperplasia and fusion of gill lamellae; intranuclear inclusion (arrow) in the branchial epithelium (gill section with H & E).

SOME CURRENT AND POTENTIAL EMERGING DISEASE PROBLEMS

The following section discusses several serious diseases of aquatic animals that are currently expanding their range in the Asia-Pacific or, although of limited distribution in the region, have the potential to expand their ranges and cause significant losses. Of these, white tail disease (WTD) has not been monitored by NACA/FAO/OIE and thus has received little attention. It will thus be discussed in more detail than the other, better known diseases.

White tail disease

White tail disease (WTD) (also reported as "whitish muscle disease" by Chinese workers) has caused epizootic losses of postlarval giant river prawns (*Macrobrachium rosenbergii*) in southern Taiwan Province of China (Taiwan POC) since 1992. The disease, which can cause mortalities of up to 100 percent of postlarvae (PL) in hatcheries, has also been reported from *M. rosenbergii* from mainland China, the French West Indies and India (see Arcier *et al.*, 1999; Sri Widada *et al.*, 2003; Qian *et al.*, 2003; Sahul Hameed, 2004). In India, it was first reported in 2003 as affecting many hatcheries at Nellore, Andra Pradesh and Chennai, and has also been seen in farms in Nellore, Andhra Pradesh (Hameed, 2004; NACA, 2004). WTD appears to spread rapidly, causing heavy economic losses due to high mortalities.

The probable cause of WTD is the *Macrobrachium rosenbergii* nodavirus (MrNV), also reported as *Macrobrachium* muscle virus (MMV) by Tung, Wang and Chen (1999). However, as noted by Sri Widada *et al.* (2003), the virus-host interactions and modes of transmission of this disease are still unknown.

The clinical signs of the disease in severely affected postlarvae (PL), which are similar to those of idiopathic muscle necrosis (IMN) syndrome (see Nash *et al.*, 1987) and thus not sufficient for presumptive diagnosis, include white opaque areas in the abdominal segments, commonly accompanied by lethargy and anorexia (see Tung, Wang and Chen, 1999; Arcier *et al.*, 1999; Sahul Hameed, 2004; NACA, 2004). Severe cases may show degeneration of the telson and uropods. Mortalities of 100 percent may occur within two or three days of the appearance of muscle opacity. Experimental infections indicate that infections may be responsible for branchostegite blister disease (BBD) or "swollen head syndrome" in adults (see Sahul Hameed, 2004; NACA, 2004).

The histopathological changes seen are similar to those described for IMN and include progressive segmental myofibre degeneration of muscle fibres and necrobiotic myopathy with numerous single, rows, aggregations and sheets of hyperchromatic myonuclei. Centrally or eccentrically placed (nuclear internalization) pyknotic nuclei were also frequently observed. However, unlike IMN, cytoplasmic inclusion bodies have been detected in the necrotic muscle of diseased prawns (see Tung, Wang and Chen, 1999). Transmission electron microscopy (TEM) of tissue homogenates from diseased prawns has revealed the presence of numerous non-enveloped virus-like particles of about 30 nm in diameter (Arcier *et al.*, 1999).

Initially, the use of pryonin methyl green was recommended (see Tung, Wang and Chen, 1999) to distinguish the characteristically green-stained MrNV viral inclusions from hemocyte nuclei. More recently Sri Widada *et al.* (2003) have developed three complimentary genome-based detection methods (dot-blot hybridization, *in situ* hybridization and reverse transcriptase-polymerase chain reaction (RT-PCR)) for detection of MrNV, dot-blot hybridization being considered the easiest to perform. In addition, Romestand and Bonami (2003) have developed a sandwich enzyme linked immmunosorbent assay (S-ELISA) for detection of this virus.

A second virus, extra small virus (XSV), whose role, if any, in producing WTD is unclear, was first reported in *M. rosenbergii* postlarvae from mainland China having concurrent infections with MrNV (Qian *et al.*, 2003). Qian *et al.* (2003) suggested that XSV, which is located in the muscle and connective cells of diseased animals, could be a helper virus for MrNV or a satellite-like virus, possibly acting as a disease modulator. It has also been considered a satellite virus by Widada and Bonami (2004). Although Qian *et al.* (2003) believed that XSV was always associated with MrNV, results presented by Sri Widada *et al.* (2004) suggest that this is not always the case. These authors concluded that the cause of WTD may be more complex than previously thought and thus further investigation is required.

Transmission electron microscopy (TEM) has revealed that the XSV viral particle is isocohedral and about 15 nm in diameter. Genome-based diagnostic techniques (dot-blot hybridization and RT-PCR) for XSV have been developed by Sri Widada *et al.* (2004).

Taura syndrome

Taura syndrome (TS) was first detected in shrimp farms near the Taura River, Ecuador (hence the name of the disease) in 1992. It then spread throughout most shrimp-growing regions of Latin America and the Pacific coasts of Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama and Peru. It was also introduced to Hawaii but was successfully eradicated.

Erickson *et al.* (2002) reported that anecdotal evidence of occurrences of TS epizootics in *L. stylirostris* since 1999 in Mexico suggests that a closely related virus might have evolved from the original Ecuadorian/Hawaiian isolate characterized by Bonami *et al.* (1997) and Mari *et al.* (2002). They noted the possibility that since 1994 a change in Taura syndrome virus (TSV) structural protein may have occurred and that this change is now responsible for the emergence of TS in *L. stylirostris*, a previously refractive species (Brock *et al.*, 1997).

Survivors of acute TSV infection pass through a brief transitional phase and enter the chronic phase, which may persist for the rest of their lives. This subclinical phase of infection is believed to have contributed to the spread of the disease via carriage of viable virus.

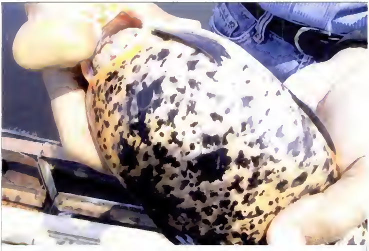
TS has recently spread to Asia through the introduction of *Litopenaeus vannamei* and has now been reported from Taiwan POC, Indonesia, Malaysia (suspected), Thailand and Viet Nam (Palanisamy, 2004; Sunarto *et al.*, 2004; de la Peña, 2004; Van, 2004).

In Indonesia, TSV was first discovered in shrimp culture in November 2002 in *L. vannamei* from East Java (see Sunarto *et al.*, 2004). It is suspected that TSV first occurred in Banyuwangi and Situbono before spreading to other districts of East Java through the movement of infected PL. Samples testing positive by PCR have also been detected from Brebes (central Java), Situbondo (East Java) and the islands of Bali, Sulawesi and Sumbawa. It thus appears that the virus is now widespread in Indonesian shrimp culture where it causes mortalities in 1-2 month old *L. vannamei* reared in intensive culture systems.

Koi herpes virus (=carp nephritis and gill necrosis virus)

Koi herpes virus disease first appeared in the Asia-Pacific Region in March 2002 in Indonesia and in Taiwan POC in December of the same year, with subsequent outbreaks in Japan beginning in October 2003 (see Lio-Po, 2004; Tu *et al.*, 2004, Sano *et al.*, 2004; Sunarto *et al.*, 2004). Earlier reports of infections with Koi herpes virus (KHV) are recorded for the Republic of Korea (1998, suspected –reported as viral infection causing mass mortality of koi and common carp), Malaysia (2000) and Japan (2000).

An interesting characteristic of the disease has been its rapid spread across Indonesia and Japan through the trade in live koi for the ornamental fish trade and common carp for foodfish production. In both cases this has been due to the disease appearing rapidly in major production areas, and its rapid dissemination through the live fish trade. By the end of May 2004, KHV had been reported from 24 of Japan's 47 prefectures (Sano *et al.*, 2004), while in Indonesia, the disease has now spread throughout much of Java and into South Sumatra (see Sunarto *et al.*, 2004).



STUART MILLAR

Koi carp infected with Koi herpesvirus (KHV)

In both Indonesia and Japan, losses have been significant. In Lake Kasumigaura, Japan, mortalities of almost 100 percent occurred in netpen culture, with a total loss of almost 25 percent of the lake's annual production. In Indonesia, the first occurrence of mass mortalities due to KHV occurred in cultured koi in March 2002 in Blitar, East Java. Mortalities of up to 80-95 percent were seen in koi carp of all ages. As Blitar is the center of koi production for Indonesia, diseased fish were rapidly transported throughout the country, with Central Java, West Java and Jakarta being the main markets. Common carp is an important foodfish in Indonesia, and KHV rapidly impacted carp aquaculture production. Epizootics subsequently occurred in Subang Regency (West Java) in April 2002 and then in neighbouring areas. The disease has continued to spread through the transfer of live infected carp, with outbreaks occurring in May-June in carp cultured in netcages in the Citarum River system and by February 2003, it had been translocated to Lubuk Lingau Regency, South Sumatra along with carp moved from West Java by fish traders. It has since continued its spread to neighbouring provinces.

The origins of KHV remain obscure. In Indonesia, the disease is thought to have been introduced with the importation of koi from mainland China (via Hong Kong) in December 2001 and January 2002. Earlier, KHV had been reported from Israel, the United States and the United Kingdom in 1998, with subsequent cases in nine other European countries and in South Africa (see Crane, Sano and Komar, 2004).

The social and economic impacts of KHV in Indonesia are still being felt. In Blitar alone, the disease has affected more than 5 000 carp culturists with economic losses exceeding Rp 5 billion during the first three months of the outbreak. As of December 2003, the total losses due to KHV due to revenue lost to the carp culture sector and the accompanying impact on rural farming communities was estimated at some US$15 million (Sunarto *et al.*, 2004).

Grouper iridoviral disease

Grouper iridoviral disease, also known as "sleepy grouper disease", is caused by grouper irodovirus (GIV). It affects groupers (*Epinephelus* spp.) in South and East Asia, having been reported from Taipei, Hong Kong and PR China (suspected), Singapore

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and Viet Nam (see Nakajima, 2003; Table 2). It is a problem in grouper culture, where it causes losses of fry, juveniles and market-size fish. As "sleeper grouper disease" has also been reported from Malaysia and Thailand (see Kasornchandra, 2002), the virus probably naturally occurs throughout much of Southeast and East Asia where grouper are cultured. Because most grouper fry used for stocking are still wild-caught, it is probably also widely distributed in wild grouper populations.

Spring viraemia of carp

Although spring viraemia of carp (SVC) has traditionally been considered a disease of European countries having low water temperatures during winter (FAO, 2001), SVC virus has recently been isolated from China P.R. As Chinese carps, the principal species affected by SVC, are widely cultured throughout Asia, the disease has the potential to affect carp culture wherever suitably low temperatures (11-17 °C) occur.

Withering syndrome of abalone

Withering syndrome of abalone is caused by an intracellular prokaryote, the rickettsia-like organism *Candidatus Xenohaliotis californiensis*, which infects the epithelium of the digestive tract (see Bower, 2004). Although its confirmed distribution is the Pacific coast of southern California to Baja, Mexico, a similar disease has been reported from northern China, and rickettisia-like organisms have also been reported from abalone cultured in South Africa. Although the presence of this pathogen in the Asia-Pacific has not yet been confirmed, the disease was recently added to the NACA/ FAO/OIE Quarterly Aquatic Animal Disease (QAAD) Reporting System.

The disease is lethal to all sizes of abalone (genus *Haliotis*), in which it causes lethargy, retracted visceral tissues and atrophy of the foot muscle, affecting the abalone's ability to adhere to the substrate.

Akoya oyster disease

Akoya oyster disease is as yet known only from Japan, where it first appeared in 1994. It affects Japanese pearl oyster, *Pinctata fucata martensii*, of at least one year old or older, causing stunting, tissue atrophy and cytopathological changes (see Wada, 2003). It causes significant economic losses to the pearl culture industry in southern Japan, disease outbreaks occurring at high water temperatures (above 20 °C). Although a virus has been isolated from diseased oysters, its role in the disease has not been shown, and thus the causative agent is still considered to be unknown. Because the disease is believed to be caused by a biological agent, and causes significant mortalities of pearl oysters, which are widely cultured and have significant economic value in many countries of the Asia-Pacific Region, Akoya oyster disease was recently added to the NACA/FAO/OIE QAAD Reporting System.

CONCLUSIONS

Countries in the Asia-Pacific remain highly vulnerable to transboundary aquatic animal diseases. As the recent introduction and spread of KHV throughout most of Japan and in Indonesia has shown, governments can be easily caught unawares by new diseases. To better protect themselves from exotic diseases, countries in the Asia-Pacific Region should undertake risk analyses to determine which transboundary diseases are most likely to gain entry via their current trading practices, and of these, which are most likely to cause serious damage to their aquaculture industries and capture fisheries. Based on this knowledge, national governments should take steps to reduce the risk of pathogen entry through health certification, quarantine and/or other appropriate risk mitigation measures. They should also initiate contingency planning to develop emergency response plans that will limit the spread and impacts of such diseases. Along with this, the other components of a National Aquatic Animal Health Strategy should be given high priority, so that the necessary legislation, expertise and capacity to deal with a disease emergency is in place before a serious disease outbreak due to an exotic pathogen occurs.

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Aquatic disease emergencies and implications to international trade

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ABSTRACT

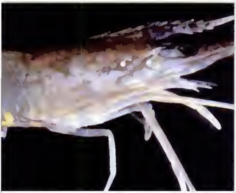
The threat to international trade as a result of aquatic animal disease emergencies is growing. Increasingly, the response to health emergencies is to guard aquatic animal resources from disease in order to protect environmental values, investment, production, market access and consumer confidence. The Sanitary and Phytosanitary Agreement (SPS Agreement) of the World Trade Organization (WTO) provides the international framework within which governments respond to disease emergencies. The SPS Agreement provides special status to the recommendations of the World Organisation for Animal Health (OIE) that deal with trade in aquatic animal commodities and related matters. The effectiveness of emergency response procedures will inevitably impact on the response of trading partners to disease threats.

INTRODUCTION

The sources of aquatic animal products and the patterns of international trade in them are changing. Aquaculture production is growing rapidly, at a higher rate than for the terrestrial farmed meat production sectors (since 1970, at 9.2 percent *per annum* compared to 2.8 percent). In the same period, the capture fisheries sector has only grown at 1.4 percent *per annum*. About 27 percent of aquatic animal production (by weight) is now from aquaculture. The pattern of international trade in aquatic animal products is also changing, and 37 percent of aquatic animal production is traded internationally, with significant shifts in the source and destination of the product (FAO, 2002).

Aquaculture is an innovative industry; many species are being cultured, in many locations, under a variety of environmental and husbandry conditions. This has lead to new challenges, particularly when new disease syndromes emerge, often precipitated by high stocking densities, exposure to alien pathogens, stressful environmental conditions and inadequate husbandry.

Investment in aquaculture and the property values of capture fisheries bring new economic imperatives to derive a return and protect the investment from threats such as disease. Disease outbreaks are a common event in modern aquaculture, and concerns of spill-over into wild populations are regularly aired. In light of this, the response to dealing with and preventing aquatic animal disease emergencies is changing.



A juvenile P. monodon *with distinctive white spots of WSD*

DV LIGHTNER

EMERGENCIES

Emergency situations can arise for different reasons, such as environmental disasters, significant disease occurrences and residue findings. The common result is that sudden and urgent action is required to manage the situation to minimize losses. Disease emergencies can take several different forms – the recognition of a novel disease, the appearance of a disease in a new location or in a new host species (including humans), or a disease taking on a more virulent form. A rapid response is required to assess the situation, limit further biological losses, stop spread and provide reassurance to markets.

In recent times, there are many examples of disease emergencies affecting aquatic animals, such as whitespot, Taura syndrome, infectious salmon anaemia and Koi herpes virus. It is reasonable to expect that aquatic animal emergencies will continue to occur for the foreseeable future because of the widespread movement of genetic materials for aquaculture purposes, the movement and reswimming (re-immersion) of live product for human consumption, the movement of aquaculture species into environments where they encounter new pathogens, the adaptation of new aquaculture species to commercial production exposing them to hitherto unrecognized pathogens and so on.

With the terrestrial animal industries, disease emergencies are frequently associated with the disruption of markets for two reasons: firstly, from the loss of consumer confidence and their switching to alternative products and secondly, from loss of market due to technical impediments. The response to the emergency, especially the level of trust in the authorities undertaking the response, will be instrumental in determining how rapidly the market can be regained.

Historically, there have been few restrictions on the international movement of aquatic animals and their products. Thus the biological loss of production caused by the disease emergency has been in general greater than losses due to disruption of markets, though the loss of markets to competing traders may have a continuing longer-term impact.

This is changing as the economic, environmental and social values of aquatic animals are recognized and as the increased threat of disease spread is appreciated. In general, restrictions in response to emergencies are likely to be directed at the movement of live animals and their genetic materials. However, it should be expected that increased scrutiny will be paid to the movement of aquatic animal products during disease emergencies, especially to those from emergency harvest or those that are not highly processed.

WORLD ORGANISATION FOR ANIMAL HEALTH – OIE

International biosecurity standards for the movement of aquatic animals and their products have lagged behind those for terrestrial animals. As aquaculture has increased in importance, international standards have been developed by the World Organisation for Animal Health (the Office International des Épizooties, OIE). The diseases addressed by the OIE have reflected the species that are of importance to aquaculture and the state of knowledge. The movement of broodstock and genetic materials have been the focus of its activities, but more recently the movement of products is being increasingly considered.

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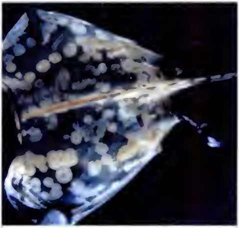
The current OIE Aquatic Animal Health Code 2004 – the Aquatic Code (OIE, 2004) contains recommended measures for the movement of live aquatic animals and their genetic material susceptible to the listed diseases. The Aquatic Code also contains recommendations for dead, uneviscerated fish and dead crustaceans of species susceptible to the OIE-listed diseases. The Aquatic Animal Health Standards Commission will be redrafting the Aquatic Code to introduce the concept of "safe commodities". These are commodities that can be traded safely, regardless of the animal health status of the source. The Commission will also attempt to grade the level of risk for other commodities.

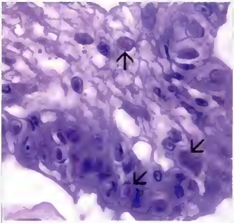


Carapace from a juvenile P. monodon *with WSD. Calcareous deposits on the underside of the shell account for the white spots*

DV LIGHTNER/P SAIBABA

Member countries of the OIE also have obligations with regard to reporting particular disease occurrences through the OIE to the international community. Disease reporting is intended to assist in minimizing disease spread and aiding disease control. OIE members are obliged to report not only the occurrence of disease but also the presence of the causative agent in the absence of clinical disease.

In certain circumstances, such as a change in disease status or where information will be of epidemiological significance to trading partners, reports must be made within 24 hours. This is commonly referred to as emergency reporting. Situations covered by emergency reporting include the outbreak of a disease in countries or zones previously considered to be free, occurrence of a listed disease in a new host species, identification of a new strain or disease manifestation of a listed disease, situations where a listed disease has potential to spread internationally, newly recognized zoonotic potential for a listed disease and recognition of new emerging diseases and pathogens.



Histological section from the stomach of a juvenile P. chinensis *infected with WSD. Prominent intranuclear inclusion bodies are abundant in the cuticular epithelium and subcuticular*

DV LIGHTNER

The Aquatic Code also provides rules by which a free status can be restored to a country or zone that has suffered a disease outbreak. In the case of "stamping out" (i.e. disease eradication), this relies on following the methods detailed in the appropriate chapters of the Aquatic Code, a surveillance scheme and no new infections being recognized.

Timely and accurate reporting to the OIE is usually an important consideration when assessing trading partners and responding to disease

Juvenile, pond-reared P. vannamei *(c – from Ecuador; d – from Texas; e – from Mexico) showing melanized foci mark sites of resolving cuticular epithelium necrosis due to TSV infection.*

DV LIGHTNER/F JIMENEZ

emergencies. Members are also to provide information on control measures taken to prevent spread, including on live animals, animal products and other things that could transmit disease.

Health certification is the basis of much international trade where measures are used to address sanitary and phytosanitary (SPS) concerns. Unreliable and inaccurate reporting of disease emergencies may have a broader effect on the trading relationship, spilling over into the acceptance of routine certification.

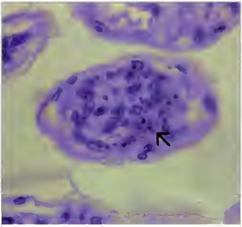
THE AGREEMENT ON THE APPLICATION OF SANITARY AND PHYTOSANITARY MEASURES

The World Trade Organization's (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) provides a basic right to WTO member countries to take necessary measures to protect human, animal or plant life or health. With this right come certain obligations, including that such protective measures must be based on a risk assessment or conform to an international standard. In the case of aquatic animal health, the measures in the Aquatic Code are the relevant international standards. If an aquatic disease emergency involved a disease listed by the OIE, a WTO member would be justified in restricting trade to the extent specified in the Aquatic Code.

WTO members are also able to take provisional measures in cases where relevant scientific evidence is insufficient for the risk assessment. This is often the situation in aquatic disease emergencies while the disease agent is being identified, the extent of its spread determined, the effectiveness of control measures assessed, and trace back and trace forward investigations are continuing. A WTO member adopting provisional measures must consider the available pertinent information, including international standards, seek further information to assess the risk and review the measure in a timely manner.

In practice, trading partners are becoming more likely to restrict trade in response to an aquatic disease emergency if they perceive a threat to their own aquatic resources. Such restrictions will be minimized by accurate international reporting and prompt action to control the outbreak. Previously prepared contingency plans effectively implemented increase the probability that disease outbreaks will be efficiently controlled. Obtaining cooperation from all of the participants in the midst of a response is likely to be difficult and may compromise the potential effectiveness of control and eradication. Trading partners need early and accurate advice, which is frequently updated, if they are to have confidence in the response and remove unnecessary trade restrictions.

Individual aquaculture producers can practice on-farm biosecurity to help minimize losses and facilitate a faster return to market. The OIE's Aquatic Animal Health Standards Commission is introducing the concept of "compartment" into the Code, which will help facilitate recognition of a higher health status on individual farms based on their health status, surveillance, control and biosecurity measures.



Focal TSV lesions in the gills (arrow). Nuclear pyknosis and karyorrhexis, increased cytoplasmic eosinophilia, and an abundance of variably staining generally spherical cytoplasmic inclusions are distinguishing characteristics of the lesions. 900x magnification.

DV LIGHTNER

CONCLUSIONS

At present, the impact on international trade resulting from aquatic disease emergencies is not great when compared to impacts that follow disease emergencies affecting terrestrial animals. This is not to diminish or understate the economic, social and environmental losses that occur in aquatic disease emergencies, particularly when there are severe biological losses in the affected species. However many countries have few biosecurity controls on the movement of aquatic animals and their products when compared to the terrestrial animal situation. This approach is changing with the recognition of the value of wild fisheries and the level of investment in aquaculture.

The SPS Agreement provides for the use of biosecurity measures to protect life and health. The OIE has disease-reporting obligations and recommendations for trade in aquatic animals and their products with regard to listed diseases. Although rapid and accurate reporting of aquatic disease emergencies may have consequences for trade, the building of trust will have longer-term benefits. Trust is the basis of trade, the international trading system and its certification system for SPS matters.

Early and accurate reporting of disease emergencies helps to build trust and facilitates the reinstatement of normal trading relations following a disease emergency. The longer access to a market is lost, the more difficult it becomes to regain market share taken by competitors and to rebuild commercial confidence as a reliable supplier.

For countries to meet their SPS obligations and international standards of the OIE Aquatic Code, a suitable infrastructure is required. The aquatic animal industries are growing globally at a rate faster than the development of the supporting infrastructure and expertise. SPS capacity can be strengthened in a number of ways, and this workshop will offer guidance and assistance to this end.

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The Food and Agriculture Organization of the United Nations' Emergency Prevention System (EMPRES-Livestock) and experiences in developing countries

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ABSTRACT

FAO's Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES), promotes the effective containment and control of the most serious epidemic livestock diseases, such as foot-and-mouth disease, rinderpest, contagious bovine pleuropneumonia, avian influenza, classical swine fever and Rift Valley fever, some which have public health implications. EMPRES also attends to newly emerging diseases and applies methods of progressive elimination on a regional and global basis through international cooperation involving (i) early warning, (ii) early reaction, (iii) enabling research and (iv) coordination. Major economic losses to livestock and producers the world over due to major outbreaks of transboundary animal diseases (TADs) such as foot-and-mouth disease (1997–2003), classical swine fever in the Caribbean and Europe (1996–2002), rinderpest in the Somali ecosystem (2001 and 2003), and Rift Valley fever into the Arabian Peninsula (2000) have been the main stimulus for the initiative to create a Global Framework for the Progressive Control of TADs with the Office International des Épizooties. Both organizations have examined the problem of TADs from the perspective of the complexity of the world food chain and human welfare, as well as the international public goods of equity, conservation of natural resources and public health

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and propose that effective prevention and progressive control of the major transboundary animal diseases is an essential contribution to the achievement of the Millennium Development Goals. The objectives of the GF-TADs initiative are to: safeguard the livestock industry of developed as well as developing countries from repeated incursions of infectious disease epidemics, to improve food security and incomes of developing countries, and to promote safe trade in livestock and animal products at the national, regional and international levels. These goals can be best achieved if the major TADs are controlled at *source of infection*, which is mainly in the developing countries.

INTRODUCTION

The overall priority of the Food and Agriculture Organization of the United Nations (FAO) is the encouragement of sustainable agriculture and rural development. This priority is met by FAO's long-term strategy to increase food production and food security while conserving and managing natural resources and reducing poverty. According to its constitution and mandate, granted by the Member Countries, FAO provides independent advice to governments on agricultural policy and planning, as well as on the legal structures needed for development (including rural development, food security and the alleviation of poverty); development assistance through a wide range of technical assistance projects; the collection, analysis, interpretation and dissemination of information relating to food, agriculture, forestry and fisheries; and offers reference and educational material to farmers, scientists and non-governmental organizations (NGOs) so as to enable rational decisions on planning, investment, marketing, research and training. FAO provides a neutral forum where all nations can discuss, formulate and negotiate policy on major food and agriculture issues.

THE PRIORITIES OF THE FAO

The five corporate strategies expressed in FAO's Strategic Framework 2000–2015 are:

- contributing to the eradication of food insecurity and rural poverty;
- promoting, developing and reinforcing policy and regulatory frameworks for food, agriculture, fisheries and forestry;
- creating sustainable increases in the supply and availability of food and other products from the crop, livestock, fisheries and forestry sectors;
- supporting the conservation, improvement and sustainable use of natural resources for food and agriculture; and
- improving decision-making through the provision of information and assessments and fostering of knowledge management for food and agriculture.

In 1994, the Director-General of FAO established two priority programmes in support of such strategy, the Special Programme in Food Security (SPFS) and the EMPRES[1]. The two components of EMPRES are those of the desert locust in crops and the livestock component that focuses on epidemic animal diseases. The latter is placed within the Infectious Diseases Group, Animal Health Service (AGAH) within the Division of Animal Production and Health (AGA). The EMPRES concepts are encompassed in all five of the FAO priorities.

THE EMPRES VISION AND CONCEPT

FAO, within its global mandate related to animal health, has traditionally played an eminent role in the fight against epidemic diseases of livestock.[2] However, upon taking office, the Director-General decided to step up FAO's role in the control and prevention of emergencies, to respond to the need to develop more effective mechanisms that would alert Member Countries to impending transboundary disease problems, as well as to develop FAO's ability to monitor and forecast the spread of animal diseases. The EMPRES concept encompasses animal diseases of a transboundary nature, which have been defined as:

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[1] 106th FAO Council Session, May-June, 1994.

[2] Rinderpest (Pan African Rinderpest Campaign 1980 and Joint Programme 15 (1970); foot-and-mouth disease (European Commission for FMD since 1952); screwworm in Libya/North Africa (1988).

> *"... those that are of significant economic, trade and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion, requires co-operation between several countries".*

The EMPRES vision is to promote the effective containment and control of the most serious epidemic livestock diseases. EMPRES also attends to newly emerging diseases and applies methods of progressive elimination on a regional and global basis through international cooperation involving (i) early warning, (ii) early reaction, (iii) enabling research and (iv) coordination.. The EMPRES Programme has established itself as a major initiative of FAO, well acknowledged as fulfilling an important development role. The World Food Summit in 1996 under Commitment Number 3[1] and FAO conferences have emphasized its relevance and importance.

Funding for EMPRES activities is part of the FAO Regular Programme described under the Department of Agriculture. These activities are normative in nature and address aspects of disease spread and strategy development for containment, capacity building, awareness and technology transfer, as well as information in the form of manuals, booklets, CDs, videos etc. Included is the financial support to the World Reference Laboratory for Foot-and-Mouth Disease and the World Reference Laboratories for Rinderpest and other Morbilliviruses, located at Pirbright, United Kingdom, and Montpellier, France, and the extensive collaboration with the Joint Division of FAO/International Atomic Energy Agency (IAEA) in Vienna. There are some 30 FAO Collaborating Centres and Reference Laboratories that assist EMPRES in their speciality areas or competence in applied research for specific diseases of direct relevance to EMPRES needs. EMPRES also incorporates the Secretariat for the Global Rinderpest Eradication Programme, actively participates in Office International des Épizooties (OIE) standard setting upon request, and forms part of advisory or steering committees in several initiatives around the world (e.g. the Pan African Programme for the Control of Epizootics/African Union-Inter African Bureau for Animal Resources). Also within the Animal Health Service, the Secretariat of the European Commission for the Control of FMD resides, dedicating its efforts to prevent incursion of foot-and-mouth disease (FMD) into Europe, promoting applied research and technology exchange, and supporting countries neighbouring Europe in FMD surveillance activities. This commission, financed through a European Community (EC) Trust Fund, extends well beyond the European Union, to include 33 countries.

Rinderpest, also known as cattle plague, is characterized by fever, depression, dehydration, diarrhoea, and high mortality

FAO

FAO Member Countries requesting assistance can benefit from its Technical Cooperation Programme, which may provide funds (up to US$400 000 per project), training, equipment, vaccine

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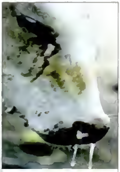
[1] Commitment Number 3: "Seek to ensure effective prevention and progressive control of plant and animal pests and diseases, including especially those which are of transboundary nature, such as rinderpest, cattle tick, foot and mouth disease and desert locust,...".



JUAN LUBROTH

Clinical signs of Rinderpest

and expertise to meet priority development needs. EMPRES operates numerous emergency or regular Technical Cooperation Projects (TCPs, Figure 1) for several of the most devastating animal diseases such as FDM, rinderpest, contagious bovine pleuropneumonia, *peste des petits ruminants*, Newcastle disease, Rift Valley fever, classical swine fever (CSF), African swine fever, sheep pox, brucellosis and haemorrhagic septicaemia. In addition, inputs from FAO include: surveillance systems (including global information systems (GIS) based field observation/abattoir data software) known as TAD*info*, emergency preparedness, contingency planning, veterinary vaccine technology transfer, participatory epidemiological approaches, enabling legislation and evaluation of veterinary services.

The diseases or needs addressed by EMPRES were: In **Asia**, FMD, Rift Valley fever, CSF, rinderpest, *peste des petits ruminants*, information systems, project evaluation and border control. In **Africa**, contagious bovine pleuropneumonia, African swine fever, FMD, Rift Valley fever, rinderpest, *peste des petits ruminants*, Newcastle disease, veterinary vaccines, laboratory training and equipment, molecular analysis of viral strains, surveillance systems, participatory approaches to epidemiology and participatory disease search, modeling of disease transmission, remote sensing and prediction, animal identification and evaluation of legislation. In the **Americas**, EMPRES inputs included molecular characterization of FMD viral strains, the promotion of the Hemispheric Plan for CSF eradication, public awareness, surveillance methods and information systems.

Other activities in which EMPRES (including others within the Animal Health Service and AGA) has been involved include:

- inputs for the livestock sector rehabilitation in post-war Iraq;
- livestock sector rehabilitation in Afghanistan, Kosovo and Rwanda;
- studies to identify possible animal reservoirs for the severe respiratory acute syndrome (SARS) coronavirus in China; and
- presentations at the Biological Weapons Convention meetings.

The EMPRES Projects depicted in Figure 1 (2002–2004) do not include trust-funded projects or specific extra-budgetary projects for agriculture or animal health where the Infectious Disease Group has held responsibility.

It is apparent to EMPRES itself that all its inputs are insufficient to curtail the devastation caused by transboundary animal diseases and their impacts on food security and the livelihoods of poor animal farmers, pastoral communities, and the viability of dairy cooperatives and commercial enterprises. The long-term vision of EMPRES is to have a large cadre of trained professionals and para-professionals that would curb disease incidence and implement the required control strategies through better surveillance, early warning, early detection and early reaction. As EMPRES works to meet these needs for individual countries, these inputs are often not sustainable for various reasons. These include such factors as: the poor animal health status of a neighbouring country; low efficiency in carrying out planned activities, inconsistent training; attrition of personnel (i.e. key individuals departing from public service for the acceptance of greater administrative responsibilities[4], succumbing to disease[5] or desiring to find a place within the private sector in clinical practice, pharmaceutical representation or consultancy). Recognizing that transboundary animal disease respects no political boundaries, EMPRES, has sought to work beyond individual country projects at the regional level in coordination with various countries and stakeholders. An initiative, in partnership with the Office International des Épizooties (OIE), to coordinate counter-epizootic measures and strengthen veterinary systems was therefore undertaken in 2002, under the working title: "The Global Framework for the Progressive Control of Transboundary Animal Diseases (GF-TADs)."

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[4] Sometimes precisely because a postgraduate technical degree was obtained.

[5] Reference is made to the devastating effect of human immunodeficiency virus infection and the acute immunodeficiency syndrome (HIV/AIDS) on a village population, where mortality among adults in certain parts of Africa exceeds 30 percent. A capacity building course on community animal health and production would theoretically need to be repeated every two years or else the need to commence the process from the beginning every time. The same would be true for water management, soil conservation, fisheries or crop rotation initiatives etc.

THE GLOBAL FRAMEWORK FOR THE PROGRESSIVE CONTROL OF TRANSBOUNDARY ANIMAL DISEASES (GF-TADS)[*]

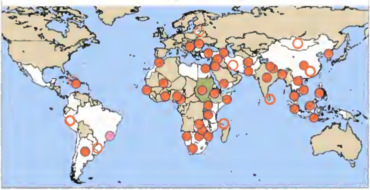
Major economic losses to livestock and producers the world over due to major outbreaks of transboundary animal diseases (TADs) such as foot-and-mouth disease (1997–2003), classical swine fever in the Caribbean and Europe (1996–2002), rinderpest in the Somali ecosystem (2001 and 2003), and Rift Valley fever into the Arabian Peninsula (2000) have been the main stimulus for the initiative to create a Global Framework for the Progressive Control of TADs. The unprecedented epidemics, both in scope and geographical occurrence, of highly pathogenic avian influenza (HPAI) that came into international attention in Asia in 2004 are symptomatic of the problems facing disease control, regional collaboration and understanding of disease ecology for better prevention. Other diseases remain unchecked – such as contagious bovine pleuropneumonia in Zambia, Angola, DR Congo and Namibia or *peste des petits ruminants* in India, Bangladesh, North Africa and the Middle East. African swine fever still causes hardship for swine production in rural and peri-urban areas in Central and West Africa.

Several international institutions have emphasized the need to control TADs due to their devastating impact on livestock agriculture, trade and food security:

- The World Food Summit (WFS), November 1996, recognized the pivotal, constraining role of TADs, and the Heads of State and Governments pledged to *"seek to ensure effective prevention and progressive control of plant and animal pests and diseases, including especially those which are of transboundary nature, such as rinderpest, cattle tick, foot and mouth disease and desert locust,.....".*

FIGURE 1

Technical Cooperation Projects 2002–2004; EMPRES (full circle) and those with EMPRES involvement or of notable mention (open circles)



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[*] GF-TADs was endorsed by Member Countries at FAO's 32nd Conference held in Rome in December 2003 and by the 72nd General Session of the OIE in Paris.

- The OIE's International Committee in 2002, called on the OIE and FAO to pursue an international concerted action against a number of diseases having significant effects on food security, poverty alleviation, food safety, public health and access to formal markets.
- The 31st Session of the FAO Conference (2001) also recognized the widespread and increasing impact of epidemic animal diseases, like FMD, and stressed the need to continue the work to combat the disease at the national, regional and international levels, involving all relevant stakeholders.
- The report of the Temporary Committee on Foot and Mouth Disease of the European Union Parliament (3 October, 2002)[7], concluded:

  > *"In view of the intensification of world trade and global warming, a thorough analysis of the existing and likely future threats arising from the introduction of animal diseases into the EU which could cause major economic damage is urgently needed at European level.*
  >
  > *Lasting success can be achieved in efforts to control FMD worldwide only if it proves possible, through close international cooperation, to curb the disease decisively in areas where it is still endemic. The Commission should therefore do more to assist the countries concerned in their efforts to control or eradicate FMD and seek to improve cooperation with regard to information (early warning systems)."*

- The WFS, five years later (2002), reiterated the 1996 commitment and called for specific action and voluntary financial contribution to the FAO Global Trust Fund to facilitate food security programmes and combat TADs.

There is ample evidence from various studies that the risk of spread of TADs will increase unless concerted international actions are put into place for effective prevention and progressive control. This conclusion is predominantly based on predictions of an unprecedented growth of the livestock sector and of the consumption of livestock products, particularly in TAD-endemic developing countries. The predicted growth in livestock is expected to result in increased livestock farming in tropical/subtropical zones, with trends towards large farming units and increase in trade in livestock and livestock products through informal and formal markets regionally and internationally.

OIE and FAO have examined the problem of TADs from the perspective of the complexity of the world food chain and human welfare, as well as the international public goods of equity, conservation of natural resources and public health. Thus the GF-TADs that is being promoted by the two organizations proposes the effective prevention and progressive control of FMD and other major TADs as an essential contribution to the achievement of the Millennium Development Goals.

The goals of GF-TADs are:

- to safeguard the livestock industry of developed as well as developing countries from repeated incursions of infectious disease epidemics;
- to improve food security and incomes of developing countries; and
- to promote safe trade in livestock and animal products at national, regional and international levels.

The above goals can be best achieved if the major TADs are controlled at source of infection, which is mainly in the developing countries. The GF-TADs programme will be developed along four main thrusts:

- Global Early Warning, Alert and Response System for major animal diseases;
- Implementing knowledge gained after decades of research at the molecular and ecological level and how it may be applied to other TADs. FMD is the TAD that all regions of the world consulted identified as a priority, as it concerns

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[7] European Parliament: Temporary Committee on Foot and Mouth Disease. Draft Report. Provisional 2002/2153(INI). 3 October 2002.
www.europarl.eu.int/meetdocs/committees/fiap/20021107/475314en.pdf

both developed and developing countries and it offers the best opportunity for developing good practices in disease management in all regions of the world;
- Completion of global rinderpest eradication[a]; and
- A flexible Regional Thrust to take account of the regional priorities in terms of target disease, epidemiology and strategy for progressive control of FMD and priority diseases agreed through regional collaboration.

The Outputs for the initial six-year (2004–2009) period are:
- establishing a robust FAO-OIE-WHO (World Health Organization) Global Early Warning System for TADs and versions for each of the major regions, in partnership with regional organizations;
- securing a global status of internationally verified freedom from rinderpest;
- defining primary endemic areas for FMD and the other selected TADs;
- developing disease control strategies based on sound epidemiological knowledge for participating countries coordinated through relevant regional organizations;
- establishing an international early response capacity for prompt and authoritative disease diagnosis and for targeted local disease control in order to limit the spread of new outbreaks of TADs;
- identifying new research programmes through advanced research institutes (ARIs), including Consultative Group on International Agricultural Research (CGIAR) centers; and
- strengthening of referral diagnostic and molecular biological capacity of FAO/OIE Reference Laboratories and a follow-up technology transfer to National Agricultural Research Systems (NARS), primarily through the established system of a network of national laboratories supported by the FAO/IAEA Joint Division and north-south/south-south partnerships.

The GF-TADs initiative is designed to provide strategic regional cooperation for the control of transboundary animal diseases by:
- Improving national knowledge and information/data retrieval systems on animal production, disease surveillance, land use, animal and product movement, and related factors that affect or threaten animal health, as do climate change, worker migration and refugee movements, and price differentials across borders;
- Strategic use of quality vaccines – where such vaccines exist, and enabling research where they do not;
- Improved diagnostic laboratory performance at the national level and support for reference laboratories for the region/world through technology transfer and internal and external quality control;
- Technical guidance in the establishment of regional initiatives ensuring collaboration across borders; and
- Implementation of Good Emergency Management Practices that include early detection, reporting and counter-epizootic measures. The epidemiologically based strategy advocated in the GF-TADs is founded on two notions: risk-based surveillance and risk-mitigation disease control.

Ruptured vesicles in the mouth of a cow affected by FMD

USDA

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[a] This thrust builds on the success of the on-going FAO Global Rinderpest Eradication Programme (GREP). Eradication is planned for 2010. Completing this major and unique undertaking of global eradication of an animal disease offers opportunity for good disease management practices through lessons learned through GREP.

It is expected that the GF-TADs programme will oversee a flexible progression in disease containment according to the various target regions, addressing features of risk reduction, evolved and strengthened national/regional control programmes, and the creation and maintenance of free zones or prescribed disease free zones. Verification of disease and infection-free status will be a reiterative process of national responsibility to ensure safe animal trade.

In addition, research into a new generation of vaccines their delivery, and diagnostic tests that will advance disease control programmes, early detection or prevention is being considered by several research centers with vast experience in FMD. Meetings with partners in the United States, the United Kingdom, Australia and Canada have already taken place to determine researchable priorities with the hope of obtaining promising advances in short periods of time, after which pilot projects could be carried out. This research programme is suggested to be coordinated with the Global Framework by an Inter-Agency Steering Committee.

It is expected that the Joint FAO/IAEA Division will continue to provide transfer of the new diagnostic technologies to developing countries as they become available, building on its 30-year experience of coordinated research and technical cooperation programmes. It is envisaged to include a financial subcontract arrangement with the FAO/OIE World and Regional Reference Laboratories in order to enhance their capacity for rapid and coordinated provision of authoritative diagnosis of epidemiologically important outbreaks, characterization and analysis of the genetic and antigenic make up of causal agents, monitoring of regional and global trends in pathogens and capacity building in national and regional laboratories. Other advanced research institutes will be contracted for specific expertise in the development of predictive methodologies and sensors, novel diagnostic techniques and more efficacious vaccines.

EARLY WARNING ACTIVITIES

Early warning concept

Early Warning was seen from the outset as a key component of EMPRES. The 1994–1995 Programme Review Report, Chapter V, observed thus:

> *"Early warning of T-PP/AD[1] situations is an important function of FAO, which has to rely largely on national systems for identifying and reporting outbreaks. Strengthening of national and regional capacities has thus been an important priority for FAO".*

Early warning has been defined as all disease initiatives, which predominantly would be based on epidemiological surveillance, that would lead to improved knowledge of the distribution of disease or infection and that might permit the forecasting or further evolution of an outbreak.

Capacity building in surveillance and early warning

This has been undertaken through a series of regional and national workshops, especially in Africa, North Africa and the Near East and in Asia. These training activities have been augmented by two specific manuals on surveillance and participatory epidemiology.

A development of greatest impact has been the development of a hierarchical software system aimed at assisting epidemiological surveillance, collection and analysis of GIS-based animal disease information at the national, regional and global levels. This unique system, called TADinfo, has been adopted or is being evaluated in several Member Countries. The system is described on the EMPRES website:
www.fao.org/ag/AGA/AGAH/EMPRES/tadinfo2/e_tadinf.htm

Regional TAD*info* is currently being field tested by the Southern African Development Community Regional Epidemiology Unit. A "global" TAD*info* system is expected to act as a major platform for the proposed FAO-OIE-WHO Global Early

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[1] Transboundary plant pest or animal disease

Warning System for Transboundary Animal Diseases (GLEWS). The global aspects are under the incipient EMPRES-*i* (*i* for *information, intelligence* and *intervention*) database for disease tracking and references linked to the FAO Global Livestock Production and Health Atlas (GLIPHA).

Early warning projects

EMPRES-Livestock has been providing technical assistance to three major regional projects:

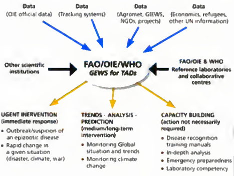
- *The Pan African Programme for the Control of Epizootics (PACE)* is conducted in collaboration with the Inter-African Bureau for Animal Resources of the African Union (AU-IBAR), with funding from the European Union. EMPRES-Livestock has provided the main epidemiologist for this five-year programme. The objective of the programme is to develop epidemio-surveillance networks for 34 countries in tropical Africa to assist with the surveillance and eventual early warning for transboundary animal diseases.
- *Regional Animal Disease Surveillance and Control (RADISCON):* This International Fund for Agricultural Development-funded project has been operating in 29 countries of North Africa, the Horn of Africa and the Middle East since 1997 and is expected to enter another phase of three years. This project has the objective of developing capacity in the region through (1) enhancing training in data management and analysis, (2) passive and active surveillance, and (3) outbreak investigation and risk analysis. The project has established national animal disease databases in a number of countries (Algeria, Egypt, Morocco, Sudan, Tunisia, Libya, Yemen, Saudi Arabia, Iraq, Kuwait) based on the TAD*info* system plus a regional reporting system, with standardized forms and an electronic information network linked to EMPRES-Livestock.
- *Early Warning in SADC:* A TCP regional project entitled Promotion of Transboundary Disease Early Warning Systems in the SADC Region covering 11 SADC countries (Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe) has assisted in strengthening the SADC Livestock Disease Early Warning system through the procurement of equipment and installation of the TAD*info* system and the associated training of national epidemiologists. This has now formed the catalyst for a pipeline project by SADC seeking to institutionalize early warning for TADs in the region.

Pipeline projects

EMPRES-Livestock is developing three pipeline projects that are likely to have a long-term impact on early warning for transboundary animal diseases. The first involves capacity building and development of an early warning system for Central Asia, with ear-marked funding from the FAO Trust Fund; the second involves enhancing national uptake of the TAD*info* system – which is still largely unfunded; and the third is expected to be developed jointly with the OIE and WHO as the Global Early Warning System for Transboundary Animal Diseases (GLEWS). The FAO-OIE-WHO GLEWS is being designed along the principles shown in Figure 2.

FIGURE 2

Schematic representation of the FAO/OIE/WHO Global Early Warning System (GLEWS) and response


Data
(OIE official data)
Data
(Tracking systems)
Data
(Agromet, GIEWS, NGOs, projects)
Data
(Economics, refugees, other UN information)
Other scientific institutions
FAO/OIE/WHO
GEWS for TADs
FAO/OIE & WHO
Reference laboratories and collaborative centres
UGENT INERVENTION
(immediate response)
• Outbreak/suspicion of an epizootic disease
• Rapid change in a given situation (disaster, climate, war)
TRENDS · ANALYSIS · PREDICTION
(medium/long-term intervention)
• Monitoring Global situation and trends
• Monitoring climate change
CAPACITY BUILDING
(action not necessarily required)
• Disease recognition training manuals
• In-depth analysis
• Emergency preparedness
• Laboratory competency

SPECIFIC EXAMPLES FOR COOPERATION AND LESSONS TO BE LEARNED

The Global Rinderpest Eradication Programme (GREP)

The immediate post-World War II period in Asia was followed by a major rinderpest epidemic in the 1950s affecting many countries in south and eastern Asia. National and regional programmes were set up to control rinderpest, the principal strategy for which was mass vaccination of the national herd. Once under control and with considerable investment, the disease likely persisted only in southern India and southern Pakistan. Nevertheless, the rinderpest control programmes initiated from 1987 were still based on the strategy of national mass vaccination, with relatively little impact on the perceived incidence of rinderpest in the region (Figure 3). The breakthrough happened once the region started to adopt an epidemiologically determined approach to disease eradication. In India, this led to recognizing that the disease was really endemic in the southern states (Tamil Nadu, Karnataka and Andra Pradesh) and that rinderpest elsewhere occurred by epidemic extension. Indian veterinary authorities concentrated their vaccination programme in the southern states and stopped vaccination in the north. No further outbreak of rinderpest has been reported in India since September 1995, and vaccination ceased in 2001. It is likely that the entire country will gain freedom of disease status by the end of 2004.

Similarly, by analysing the epidemiology of rinderpest in Pakistan and Afghanistan, it became obvious by 1996 that the 1994–1995 rinderpest epidemic in the Northern Areas of Pakistan and the 1995 and 1997 outbreaks in Afghanistan had merely represented a disease incursion from the endemic areas of southern Pakistan. On the three occasions, the outbreaks were controlled by targeted, peri-focal intensive vaccination without resorting to nation-wide blanket rinderpest vaccination.

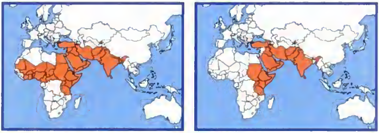
During the regional workshop jointly organized by FAO/EMPRES and the Animal Production and Health Commission for Asia (and the Pacific [APHCA]) in 1998 in Sri Lanka, each country presented its rinderpest status. It became clear that in the entire South and East Asia, there was only a single endemic focus in southern Pakistan. As a consequence, there was no justification for countries to conceive expensive programmes involving national or regional mass vaccination campaigns against rinderpest, but rather to focus on the nidus of infection.

In Pakistan, the veterinary authorities were motivated since 1998 to pursue a strategy that would be epidemiologically determined rather than the 100-fold more costly generalized blanket vaccination campaign. In the following two years, Pakistan embarked on clinical and serological surveillance with targeted vaccination of buffalo herds in the presumed endemic areas encompassing the dairy colonies of Karachi in Sindh Province. The last recorded case of rinderpest in Pakistan was in 2000, with a status of provisional freedom from disease declared in 2003. This once-Asian disease may now have been eradicated from the continent; yet, active surveillance in the most remote villages must be exhaustive.

The Middle East also experienced an epidemic of rinderpest in the 1980s, and localized outbreaks in 1991 and 1994 occurred in Turkey and northern Iraq. Outbreaks were also recorded in Saudi Arabia, Oman and Yemen between 1994 and 1996. Molecular analysis of virus samples from the region showed that the causative strains were of the Asiatic lineage, suggesting a South Asian rather than an African link to source of infection. The GREP strategy in 1994–1996 shifted from advocating mass vaccination to one of targeted control. This concentrated on three fronts: controlling rinderpest in South Asia and surveillance plus targeted control in the Kurdish ecosystem and southern Yemen, i.e. the presumed primary endemicity. Although verification is still required, rinderpest seems to have been eliminated from the Middle Eastern region without further recourse to regional blanket vaccination. Only Syria still vaccinates its national herd, although there is a commitment to halt the practice at the end of 2004. In December 2003, GREP/EMPRES held a joint Technical Advisory Meeting with the

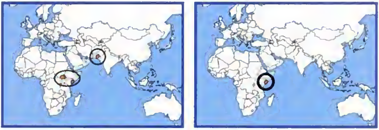
FIGURE 3

In the early 1980s (a), rinderpest was known to have been present in many countries, extending from Mauritania in the west to India in the east and as far south as Tanzania in Africa (years earlier, rinderpest extended to countries further east, including the Philippines). By the early 1990s (b), western and most of central Africa had been cleared of rinderpest, but it was still prevalent in eastern Africa. Many countries in South Asia, the Near East and the Arabian Peninsula continued to be affected. Even Europe was affected when rinderpest occurred in Georgia (and eastern Russia – not shown). In 2001 (c), there were suspicions of rinderpest persistence only in southern Sudan, the Somali ecosystem and Pakistan. The Pakistan reservoir was eliminated in 2002 (by virtue of Pakistan/EC/FAO joint effort), and this country declared provisional freedom in 2003 with subsequent recognition by the OIE. The first two maps (1980s and 1990s) show rinderpest infection status of countries by depicting whole countries as being infected, which epidemiologically is known not to be the case, even where disease occurrence was reported. The map for 2001 depicts livestock populations in which infection was suspected to be persisting and indicative of an improved epidemiological understanding. Currently, in 2004 (d), rinderpest virus is suspected to occur in the Somali ecosystem, crossing over several international borders



a) Early 1980s

b) Early 1990s



c) 2001

d) 2004

OIE in Lebanon to provide the assistance required for countries in the Middle East and Arabian Peninsula (and Iran and Iraq) to meet the internationally recognized goals of freedom from disease and infection.

In Africa, the 10-year, multidonor programme coded JP-15 from 1964 to 1975 was based on blanket vaccination of the national herds throughout Tropical Africa. Although it was expected to have countries assume responsibilities, by 1982–1984 a pandemic of rinderpest had broken out in 20 countries of Tropical Africa stretching from Somalia in the east to Mauritania in the west. A new programme, the Pan African Rinderpest Campaign (PARC) was developed in 1986 with financial support primarily from the European Union. Initially, the approach was mass vaccination. It was not until the early 1990s that the approach of addressing the disease at source started to be vigorously pursued. Using community-based vaccination and disease search methodologies with several NGOs proved an extremely useful programme in remote areas and those under civil strife (e.g. southern Sudan, with its last confirmed case in 1998).

There is an urgent need to provide such a community-based animal health programme delivery system in the area that almost certainly constitutes the last rinderpest reservoir, situated in the Horn of Africa, and to institute specific actions aimed at eliminating foci of viral infection there. Fortunately, there exists a coordinated African programme with the work being undertaken predominantly through the Pan African Programme for the Control of Epizootics (PACE), implemented by the African Union/Inter-African Bureau for Animal Resources with financial support from the European Commission and the United Kingdom through its development agency. FAO and OIE, both on the advisory committee with PACE, assist in defining the actions required to define the rinderpest situation and bring about rapid elimination of the last reservoir of infection, with appropriate surveillance programmes to verify freedom.

One of the main lessons to be learnt from GREP is that the cost of a disease eradication programme can be reduced considerably by targeting disease control to epidemiologically defined endemic areas instead of undertaking blanket, mass vaccination of the entire national herd. The approach adopted by GREP since 1994 has involved five main thrusts:

1) establishing the true epidemiological distribution of rinderpest in the world;
2) defining epidemiologically based targeted interventions for the progressive control of rinderpest where disease is suspected, thereby persuading national and regional veterinary authorities away from pursuing the conventional, generalized mass vaccination of the entire national heard;
3) defining epidemiologically based strategies for the verification of rinderpest freedom;
4) establishing participatory involvement of key stakeholders in the GREP: and
5) taking expert advice both on an individual basis and through the mechanism of the International Technical/Expert Consultations.

GREP is the only existing global disease control programme and is the single most ambitious animal health programme. From the outset in 1992, it has had the stated goal of achieving verified worldwide freedom from rinderpest by 2010. Recognition for the achievements must be shared with others, notably the OIE; the European Union and European Commission; the Organisation of African Unity/African Union; the Animal Production and Health Commission for Asia and the Pacific; the governments of the Republic of Ireland, the United States, the United Kingdom, Australia, the Netherlands and Japan; the International Atomic Energy Agency's Joint Division with FAO; and most importantly, the countries themselves.

The Hemispheric Plan for the Eradication of Foot-and-Mouth Disease – Americas

Control of this relatively new disease to South Americas[12] has benefited from concerted action by the Pan American Health Organisation (PAHO) through the establishment of the Pan American Centre for Foot-and-Mouth Disease (Panaftosa), located in Rio de Janeiro, Brazil. In 1978, the Inter-American Meeting, at the Ministerial Level, on Health and Agriculture agreed on the Hemispheric Plan for Eradication of FMD in the Americas. The three subregional plans focussed on the level of endemicity of FMD (none, as in North America; endemic – South America; and a third sphere reflective of risk and proximity). The South American countries formed a commission *(Comisión Suramericana para la Lucha Contra la Fiebre Aftosa or COSALFA), which in its early years consisted* of the official veterinary service representatives or Ministers of Agriculture, but today incorporates the private sector, through representatives from dairy cooperatives, rancher syndicates or presidents of rural associations sitting side by side with the government to strategize methods for control and evaluate performance, accountability and conformity. The *Comisión* meets annually and more frequently if an emergency arises (as it did in 2001). This partnership between the public and private sectors was extremely successful in Colombia in 1985, when a new type of FMD virus appeared in the Sabana de Bogota, in central Colombia. This particular virus appears to have been extinguished from circulation. In Argentina, this partnership extended this model to the rural communities and livestock associations, with the involvement of schools, churches, universities and police, which rapidly led to the countries' recognition of freedom with vaccination in the late 1990s.[11]

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[12] First reported in Argentina in 1870; Colombia and Venezuela in 1950, for example.

Some of the major contributions of Panaftosa in the field of FMD control are a better understanding of FMD epidemiology, persistent infections of cattle and buffalo, and vaccine use. Epidemiologists at Panaftosa devised a structure to correlate "*ecosistemas*" – virus ecological systems, land use, farming and husbandry practices, and cattle movement to identify primary endemic areas (i.e. virus maintenance areas), secondary endemic areas (areas of virus propagation) and epidemic areas (i.e. areas of explosive outbreaks). They showed that the most cost-effective and sustainable strategy for FMD control was that which targeted first the primary endemic ecosystem, which is highly correlated with a calf:cow ratio of 1. If disease is first brought under control in this ecosystem, it becomes relatively easy to achieve sustained control in the other zones and diminishes risk to elsewhere.

Panaftosa also provides regional reference diagnostic support and training, and independent vaccine evaluation for manufacturers (private or governmental). This last activity is highly relevant for FMD vaccine use elsewhere around the world, where such quality assurance is lacking. Today, major efforts by Panaftosa include country collaboration along adjoining borders and robust rural integration for animal health development.

Avian influenza – Asia, poultry, livelihoods and human health[12]

Official reports to FAO, OIE and WHO suggested that avian influenza, more commonly know as bird flu, started to assume epidemic proportions towards the end of the year 2003. However, recent, retrospective analysis suggests that in most countries the disease may have been around for many more months. This would signify that a major veterinary public and animal health problem and a socio-economic disaster of subcontinental scale unfolded itself before causing any widespread alarm. This in turn illustrates that the current avian influenza crisis is not just an emergency but also a symptom, reflecting major institutional and policy-level deficiencies that also need addressing.

The FAO/OIE/WHO Technical Consultation on the Control of Avian Influenza, held 3–4 February 2004, concluded that the current epidemic is evolving and is anticipated to continue to expand both in geographic distribution and incidence. Given that the virus circulation in the region is not considered to be under control, there is need for a concerted emergency response. Without the implementation of appropriate methods of disease control, the risk of epidemic spread to further countries, including those in distant regions, is likely to remain high, and the disease may persist as a result of infection becoming endemic in the domestic poultry population. There will be a continuing threat to human health as long as the infection is present in the poultry production systems in Asia.

As an emergency measure, the above scientific panel recommended that control programmes be immediately intensified and monitored, and that public education in veterinary training and national and regional capacity building, particularly for veterinary services, is an important part of the development of long-term surveillance and the control of highly pathogenic avian influenza (HPAI) and other priority diseases. National avian influenza task forces require major strengthening and improved surveillance. Transparent and timely reporting of infection to the OIE by the veterinary administration is required at the national, regional and international levels. Extensive international coordination should be established for short and long-term control of influenza viruses of human and animal health significance.

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[11] In 2001, shortly after receiving declaration of freedom without vaccination from the OIE, Argentina was infected by FMD virus type A after the movement of animals from a neighbouring country. Interestingly, it was the private sector that demanded immediate action although they would be adversely affected as to the loss of their privileged status.

[12] Selected and updated text from "Halting the spread of avian influenza in Asia and promoting recovery" by FAO and OIE (original February 2004).

Preventing a similar emergency in the future makes it necessary to reflect on the factors in the Asian poultry subsectors that led to this problem. Of paramount importance is the human health risk posed by HPAI flare-ups and the threat emanating from the combination of wild bird reservoirs, backyard poultry and rapid intensification and industrialization. The meeting highlighted that the current spread of HPAI virus may be viewed as a consequence of failure of surveillance networks, early warning implementation, and control of movement of infection between domestic poultry. The HPAI crisis also serves to indicate the need for a veterinary surveillance framework for early warning of disease risk at the regional level, which should serve the needs of the agricultural and medical communities of the region and the wider international community. Regional networks for epidemiological surveillance, typing of influenza and other infectious pathogens, vaccine banks and contingency stocks of vaccines complying with OIE standards may all be necessary for timely national and international early warning and effective action. Novel approaches and thinking will almost certainly be required.

Rehabilitation and restructuring of the subsector should duly reflect the importance of the smallholder and the semicommercial sector. A sizeable segment of the poultry population remains within this sector. An estimated total of 200 million farmers, mostly keeping somewhere between 10 to 100 birds including chicken, ducks, geese, turkeys and quail, constitutes a vitally important contribution to the food and income security of the rural sector. FAO is especially concerned with the loss of livelihood for the proportion of dependent poor in the affected region. Not only poultry producers but also traders, processors, marketers and food vendors, as well as persons employed in the poultry sector, are at risk of losing their livelihood. Recovery of export capabilities for regional and international market access in compliance with OIE standards of the *Terrestrial Animal Health Code* is also crucial for the rural economy of some countries of the region.

While the present document seeks to categorize the support required today (Emergency Response), tomorrow (Emergency Prevention) and beyond (Rehabilitation and Restructuring), none of these components should be viewed in isolation. On the contrary, without integrating the immediate, medium and long-range responses required, there will be no effective containment of the current emergency.

The FAO Technical Cooperation Programme (TCP) has allocated US$5.5 million to assist countries in Asia with emergency/short-term support. Within this budget, US$2.7 million was approved by mid-February 2004 for one regional TCP covering Southeast Asia and six national TCPs (China, Pakistan, Viet Nam, Cambodia, Laos and Indonesia). At the time of this writing, September 2004, all six national TCPs are far in implementation and three subregional TCPs are underway, with two additional ones approved, with launching planned in the next four to six weeks (all regional TCPs cover 21 countries of the Region. See Table 1). Such TCP-mobilization for an animal health crisis was unprecedented in scope and nature. Some of these funds, however, have been used for advocacy channels to seek additional donor input successfully for countries or regional interventions. The emergency response cannot be viewed in isolation from the longer-term rehabilitation of the poultry sector, including supportive veterinary administrations and animal health services both in the public and private sectors.

TABLE 1

Regional support units identified for the avian influenza emergency.

East Asia	PR China, Japan, North Korea, South Korea, Taiwan Province of China
Southeast Asia/Oceania	Cambodia, Laos, Viet Nam, Thailand, Myanmar, Indonesia, Malaysia, Philippines, East Timor, Papua New Guinea
South Asia	India, Bangladesh, Sri Lanka, Nepal, Bhutan, Pakistan

The strategy decisions require early identification of the desired health status by production system, a timetable to achieve this, and surveillance systems and criteria required to permit re-opening of export markets in compliance with international standards. The inputs required for individual countries depend also on the level of risk of reintroduction of infection from sectors or regions that have not controlled or eliminated reservoirs of infection (and perhaps may never). For the moment, the situation in most of the Asia Region is far from clear, and the problem in some countries is still evolving.

In order to bring the diseases back in check, the affected countries are currently engaged in a number of the following disease emergency measures:

- establishment of central command structure;
- coordination by national disease emergency control centers in veterinary administrations;
- information, reporting and communication units;
- mapping and epidemio-surveillance office;
- establishment and running of local disease control centers;
- logistical support, administration and planning;
- training and capacity building;
- consultative technical committee and inter-ministerial representation;
- use of personal protection equipment and general safety precautions;
- in-field and laboratories: surveillance and diagnostics, particularly for any suspected outbreaks; tracing contacts; sampling; laboratory support for confirmation; and assisted delivery to OIE/FAO reference laboratories;
- design and carrying out of enhanced border inspection, quarantine measures, marketing control, movement restrictions and strategic stand-still for live animal transportation;
- stamping out or culling of the affected, suspected and (high) risk units using internationally recognized methods of killing;
- disposal of birds and contaminated materials, including products;
- cleaning out and disinfection of premises;
- implementation of targeted vaccination in compliance with international requirements;
- post-outbreak surveillance to monitor infection status;
- communication with stakeholders;
- compensation to farmers; and
- monitoring and resourcing of the entire control operation.

In terms of financial resources, the operations in the field are the most costly. The killing and disposal of birds demand large numbers of staff and involve high running costs for transport, earth moving equipment and various supplies. Round-the-clock deployment of staff resources is sometimes necessary in local and national centers. Considerable financial resources go to the compensation of the affected farmers.

On the basis of all the above considerations and taking into account the variable size of the country epidemics, a conservative estimate is possible. Preliminary figures suggest that the total campaign costs may amount to several million US dollars for each of the least affected countries and up to tens of millions of US dollars for the more seriously affected countries. However, the total costs for the control operations may continue to go up in the case of a prolonged campaign necessitated by the persistence of disease flare-ups in areas that were believed to have been freed from infection. This now brings the expenditure for the control of the avian influenza epidemic across the Asia Region, excluding China, to over US$250 million.

It is anticipated that more details on the total cost of the control of the disease; its economic impact; and the requirements for rehabilitation, restructuring and restocking will become available in the coming months. With more accurate information being collated, analyzed and synthesized, it also becomes more realistic to optimize control strategies in economic terms and base different scenarios on detailed and rigorous economic analysis.

Given the current deficiencies in disease reporting, there is an urgent need to enhance early and adequate risk assessment for use within the regions and to provide a wider warning to the international community.

The FAO/OIE proposal for strengthened surveillance and control of epizootic animal diseases – through support of disease surveillance units – is expected to operate at the regional level, placing emphasis on disease risk assessment and communication within each region. Through embedding epidemiologic expertise in regional specialized organizations whose mandate is to serve member states as well as to provide essential information for early detection of changing risk, benefits go to and ownership is with the countries in each region. Clearly, the avian influenza situation highlights the need for such a regionally focussed programme.

On a regional basis and under the guidance of the GF-TADs OIE/FAO steering committee, three Regional Support Units (RSU) (in East, South East and South Asia) have been identified to support regional needs on a range of animal diseases, working with and in support of the Association of Southeast Asian Nations (ASEAN); the Southeast Asia FMD, Animal Production and Health Commission of Asia and the Pacific; and the South Asian Association for Regional Cooperation (SAARC). The principal activities of the RSU are (in relation with national veterinary services) to:

- conduct needs assessments in epidemiology units and laboratories, assess gaps in legislation and compliance with trade regulations, and organize capacity building in priority subjects;
- advise and support national priority activities identified in the GF-TADs and assist in the preparation of bankable projects in the region to address priority requirements;
- assist in activities for disease surveillance and national and international reporting;
- report and liaise with Regional Specialised Organisations, regional FAO and OIE offices and Commissions, and the GF-TADs Secretariat; and
- arrange and participate in national and regional workshops.

Regional network for laboratory support

Networking of veterinary laboratories within regions, with support from international specialist (reference) laboratories has been of proven value in raising capacity and preparedness for diagnostic activities, and especially in introducing and establishing quality assurance. A support project for laboratories in the South, East and Southeast Asian region could play a very important role to network laboratories to raise cooperation within the region, with training and technical support from FAO/OIE Reference Laboratories (e.g. Weybridge, United Kingdom and Geelong, Australia). In addition to capacity building (e.g. to comply with OIE guidelines), quality control of laboratories and inter-laboratory proficiency testing will be promoted. Contract arrangement with OIE/FAO World and Regional Reference Laboratories should support authoritative diagnosis of epidemiologically important outbreaks, characterization and analysis of the genetic and antigenic make up of causal agents, and expert input into monitoring of regional and global trends in avian influenza circulation.

PARADIGM SHIFTS

It may appear as an insurmountable task: *the Global Control and Eradication of FMD*. However, understanding of where, how and when infections occur is key in defining strategies of intervention. Although the experience of the remarkable successes against rinderpest for some 50 years was based on widespread vaccinations with a vaccine unsurpassed in medicine that conferred life-long immunity (with concurrent circulation of a immunologic similar virus, *peste des petits ruminants*), today the strategy is on halting vaccination to identify areas of specific virus maintenance, and then targeting the specific population at risk with intensive vaccination with the object of immunosterilizing susceptible animals and banishing the virus from the particular ecosystem. Discovering where agents of disease are maintained is not an easy task and requires the participation of many sectors of society, perhaps the most important being at the local village level, and as such, participatory epidemiological approaches and the use of community animal health groups become essential. In contrast, FMD has several serotypes and the current vaccine does not confer long protection. But FMD viruses share with rinderpest virus, as with other disease-causing pathogens, primary endemic areas where the virus is maintained. The shift in strategy against FMD would be better served if FMD were thought of not as caused by one virus but by seven different viruses, with a plethora of variants, each of which can cause a similar clinical disease, but each with distinctive epidemiological parameters and varied biochemistry. It is then that we can begin to appreciate FMD dynamics and design strategies to tackle subtype to subtype, occurrence to occurrences in the field, and understand the behaviour of the virus within a particular ecosystem. Such focussed campaigns would become more rational and logistical, as well as scientific, than they are today. Likewise, the lessons learnt from the experience with rinderpest, which is approaching extinction, and international efforts required to maintain interest and momentum for active surveillance and verifiable freedom from disease and infection are most valuable. Thorough epidemiological understanding of host, environment and agent are to be applied – against FMD, rinderpest and other TADs.

Vaccines are tools that assist in protecting hosts from disease but may not eliminate infection. Intelligent use of these tools (i.e. targeted vaccination, information systems, animal movement management) is not widely applied. In the case of FMD where multivalent vaccines are applied, success may be better achieved with one serotype over another, or vaccines should be better tailored to select master seed vaccine strains that better protect against circulating strains. Cooperation and designing identical strategies across borders are essential in the attempt to decrease the load of agent circulation. With the exception of South America and perhaps part of Southeast Asia, this unification of strategies against FMD is not common. The Hemispheric Plan for the control of classical swine

Vaccination campaigns for the control of transboundary animal diseases, such as FMD, need to be coordinated at the central, regional and local level. Quality vaccines need to be approved by governments

JUAN LUBROTH

fever addresses this issue, but it is the responsibility of the national programmes to implement such plans with realistic strategies, with membership of the public and private sectors and follow through using self-realized performance indicators.

To diminish the risk to the areas where a transboundary animal disease (or other) does not occur, engagement with countries and regional associations to assess out the environments where they do exist is essential, as proposed in the GF-TADs initiative. Paramount to the success of GF-TADs is the identification of primary endemic regions (i.e. hot zones). EMPRES and the GF-TADs initiative propose to address these issues to the interested investors.

CONCLUSIONS

This seminar on the emergency preparedness of transboundary animal disease in aquaculture, and fisheries in general, should ask: (1) *What can be done to reduce the vulnerability of individual countries (*vis-à-vis *risk analysis and threat mitigation)?*, (2) *What can be done to streamline resumption of trade after an occurrence of disease (recovery and rehabilitation)? and* (3) *What can be done to enhance the capacity of a developing country's trading partners in meeting SPS (sanitary and phytosanitary) requirements?*

From the perspective of transboundary animal diseases as dealt with by EMPRES, the reduction of the vulnerability of countries to disease exposure relies on their participation in ongoing regional and international efforts to curb disease incidence where such agents are known to occur naturally; on supporting efforts to identify ecological zones that are the origin of infection or where new pathogen subtypes emerge; and on undertaking prevention measures by applying risk mitigation, including networking with close and distant partners in an agreed development agenda. This latter point is essential, as it creates an understanding of risk assessment, risk management and risk communication among all involved. Thus it is to better to consider that a neighbour's situation (i.e. an incipient animal health problem) should be of concern to the region as a whole, and stimulate the preparation of contingency plans at that level prior to an emergency situation.

Among the tools required are: (1) good communication links between the field (production areas), the diagnostic and research laboratories, and the central command structures; (2) rapid and accurate diagnostic methods with epidemiologically sound response; and (3) efficacious and safe prophylactic or treatment options that can be deployed under emergency operations or programmed in progressive control campaigns.

The resumption of trade after the occurrence of a disease such as FMD, rinderpest, contagious bovine pleuropneumonia, highly pathogenic avian influenza or bovine spongiform encephalopathy, to name a few important livestock diseases,[13] would require a robust veterinary service with the necessary institutional framework to demonstrate all activities carried out in the field, the laboratory and abattoirs on the progressive control, and passive and active surveillance leading to the absence of the condition. These methods should be scientifically based and stand up to internal and external auditing. FAO has on several occasions provided assistance and inputs to strengthen such activities (notably, in the cases of rinderpest in Africa and Asia, bovine spongiform encephalopathy surveillance in South America, and the current avian influenza crisis in Asia). The OIE is the standard-setting body in its guidelines for trade in animals and commodities of animal origin (aquaculture is handled in a parallel manner but separate from terrestrial animals). Yet, trade is a relationship between two consenting countries or partners and independent of OIE guidelines; but as an increasing number of countries become signatories to the World Trade Organization (and are members of the OIE), they should observe OIE guidelines and standards in their trade relationships, thus providing necessary transparency and expediency of action.

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[13] The OIE only has specific declarations for freedom for the four mentioned diseases. Bovine spongiform encephalopathy is not considered a transboundary animal disease, as it is not explosive or highly contagious.

Enhancing the capacity of a developing country to meet international sanitary and phytosanitary requirements relies on investment in training in all aspects of administration, governance, regulation and legislation, technology, information and documentation. It should be based on equitable systems providing a level playing field (i.e. subsidies to agriculture in the developed world) and enhanced in a realistic, practical manner that allows the country to have the necessary depth with succession planning in human resources and self-assessed performance indicators. Capacity building is not a single occasion event; inputs are needed more often than is appreciated. Again, the OIE, FAO and numerous private consultancies are able to provide such guidance.

The priority within FAO is sustainable agriculture and rural development. The Global Framework for the Progressive Control of Transboundary Animal Diseases represents the collaboration of the two lead international institutions to curb the crippling effect of selected epidemic animal diseases on livestock production and trade. Under GF-TADs, developed countries would decrease the risk of introduction by reducing incidence in endemically affected areas. Developing countries, where these diseases are most often reported, would benefit from the Global Framework as the effort to strengthen veterinary services, build the necessary institutions and foment public/private partnership, which should lead to development of healthy animal production and allow rural economies to participate better in formal trade, whether local, regional or international.

ADDITIONAL RESOURCE INFORMATION

- FAO/WHO *Codex Alimetarius*
  (www.fao.org/docrep/w9114e/W9114e01.htm)
- EMPRES - Emergency Prevention System – Livestock Component (new URL coming soon)
  (www.fao.org/ag/AGA/AGAH/EMPRES/index.asp)
- FAO/IAEA Joint Division (www.iaea.org/programmes/nafa/d3/index.html)
- *FAO and Food Safety* – "Protecting the food chain" article in AG21
  www.fao.org/ag/magazine
- World Health Organization (www.who.int)
- Office International des Épizooties www.oie.int)
- Pan African Programme for the Control of Epizootics (i.e. Uganda)
  (www.deluga.cec.eu.int/en/eu_and_uganda/pace.htm)
- Centro Panamericano para la Fiebre Aftosa (www.panaftosa.org.br/novo)

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Experiences in dealing with aquatic animal disease emergencies in Asia

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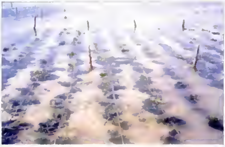
ABSTRACT

This paper presents a brief introduction to the disease problems facing aquaculture in Asia and some current efforts to deal with epizootics caused by transboundary aquatic animal diseases (TAADs).

INTRODUCTION

Aquaculture is the fastest growing food-producing sector in the world. A great proportion (over 90 percent) of this production comes from the developing world. In contrast to terrestrial farming systems, where the bulk of global production is based on a limited number of animal and plant species, the aquaculture sector comprises of over 230 different species. This large number of species cultivated reflects the diversity of the sector, particularly the wide variety of candidate species cultivated and the different production systems used. According to the latest Food and Agriculture of the United Nations (FAO) statistics, the contribution of aquaculture to global supplies of fish, crustaceans and molluscs continues to grow, increasing from 3.9 percent of total production by weight in 1970 to 29.9 percent in 2002. Aquaculture continues to grow more rapidly than all other animal food-producing sectors. Worldwide, the sector has grown at an average rate of 8.9 percent per year since 1970, compared with only 1.2 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems over the same period. Production from aquaculture has greatly outpaced population growth, with per capita supply from aquaculture increasing from 0.7 kg in 1970 to 6.4 kg in 2002, an average annual growth rate of 7.2 percent.

In 2002, total world aquaculture production (including aquatic plants) was reported to be 51.4 million tonnes by volume and US$60.0 billion by value. This represents an annual increase of 6.1 percent in volume and 2.9 percent in value, respectively, over reported figures for 2000. In 2002, countries in Asia accounted for 91.2 percent of the production and 82.0 percent of the value. Of the world total, the People's Republic of China produced 71.2 percent of the total volume and 54.7 percent of the total value of



Cultured Kappaphycus alvarezii *in fixed, off-bottom lines in Batangas, Philippines*

M G BONDAD-REANTASO

Seaweed farming (aquatic plant) in Batangas Province, Philippines

M G BONDAD-REANTASO

aquaculture production. The majority of aquaculture production of fish, crustaceans and molluscs continues to come from the freshwater environment (57.7 percent by volume and 48.4 percent by value). Mariculture contributes 36.5 percent of production and 35.7 percent of the total value. Although brackishwater production represented only 5.8 percent of production volume in 2002, it contributed 15.9 percent of the total value, reflecting the prominence of high-value crustaceans and finfish.

FISH AS NUTRITIOUS FOOD

Fish is an important part of the diet for a large proportion of the people living in the developing world. Many types and forms of fish and aquatic products are available at affordable prices in developing countries. Economic affordability is a key factor as to why aquaculture is making an essential contribution to human health in the developing world. More "foodfish" is consumed globally on a per capita basis than any other type of meat or animal protein. The main reason for the high demand for staple foodfish within most developing countries is its greater affordability to the poorer segments of the community. At present, foodfish represents the primary source of animal protein (contributing more than 25 percent of the total animal protein supply) for about one billion people within 58 countries worldwide, including many developing countries and low-income food-deficit countries (LIFDCs) (value excludes China).

Fish are important sources for many nutrients, including protein of very high quality, retinol (vitamin A), vitamin D, vitamin E, iodine and selenium. Evidence is increasing that the consumption of fish enhances brain development and learning in children, protects vision and eye health, and offers protection from cardiovascular disease and some cancers. The fats and fatty acids in fish, particularly the long-chain n-3 fatty acids (n-3 PUFA), are highly beneficial and difficult to obtain from other food sources.

Various species of aquacultured fresh and marine food fish sold in a wet market in Riga, Latvia

M G BONDAD-REANTASO

DISEASES AND HEALTH AS A CONSTRAINT TO AQUACULTURE PRODUCTION

Although aquaculture is the fastest growing food-production sector in the world, diseases are a primary constraint to the growth of the aquaculture sector in many parts of the world. A multitude of factors has contributed to the health problems currently faced by aquaculture. Over the past three decades, aquaculture has expanded, intensified and diversified, based heavily on movements of live aquatic animals and their products (broodstock, seed and feed). This trend has been triggered by changing circumstances and perspectives, especially the liberalization of world trade. New outlooks and directions have accelerated the accidental spread of diseases into new populations and geographic regions, for example, through movements of hatchery-produced stocks and new species for culture, enhancement and development of the ornamental fish trade.

QING YIN WANG

Shrimp pond in China

There is now convincing evidence of the serious socio-economic, environmental and international trade consequences arising from transboundary aquatic animal diseases (TAADs). These impacts occur on top of the routine needs of managing the opportunistic disease challenges mentioned in the Introduction. Bearing this in mind, and taking Asia-Pacific as an example of a region highly dependent upon aquaculture production and capture fisheries, we need to look at exactly what these impacts are.

Although translocation of pathogens and diseases with movements of their hosts is by no means a new phenomenon, it has only recently gained focussed attention in many regions. Advances in live aquatic animal trade, facilitated by improved transportation efficiency, are now recognized as having played a pivotal role in the introduction and spread of pathogens and diseases into many aquaculture systems. There is now convincing evidence of the serious socio-economic, environmental and international trade consequences arising from transboundary aquatic animal diseases. For instance, combined losses from shrimp diseases at the global level from 11 countries for the period 1987 to 1994 were estimated at US$3 019 million. More recent examples of major losses due to the spread of aquatic animal diseases include that of carp mortalities (losses estimated at 50 billion Indonesian rupiah, approximately US$5.5 million) in Indonesia; Koi herpes virus (KHV) (losses estimated at 150 million yen, approximately US$1.4 million) in Japan; and abalone mortalities (losses estimated at 400 million TWD, approximately US$11.4 million) in Taiwan, Province of China.

In addition to the obvious effects of large-scale aquaculture losses on rural communities, diseases also cause considerable financial impact on investor confidence. These losses are even more alarming where the success or failure of a harvest will determine the raising of families above or below the United Nations (UN) poverty threshold. In southern Viet Nam, approximately 1 200 families dependent on rice-shrimp culture have experienced annual losses of more than US$300 000 due to shrimp diseases. Between 1995 and 1997, the "red spot disease" of grass carp affected 4 000 of 5 000 cages in operation, with losses estimated at US$0.5 million. Such losses in these situations directly threaten the livelihoods of the communities they occur in through reduced food availability and loss of income and employment, as well as other associated social consequences.

Besides recent outbreaks of Taura syndrome virus (TSV) and KHV, which will be dealt with in detail in other presentations, some other examples of transboundary aquatic animal diseases in the Asia-Pacific and their impacts are briefly discussed below:

Epizootic ulcerative syndrome (EUS)

This serious epizootic, first reported in Japan as mycotic granulomatosis (MG) of freshwater ayu (*Plectoglossus altivelis*) in 1971 and observed in eastern Australia in 1972, is now reported to occur in most Southeast and South Asian countries, affecting

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Red spot disease of grass carp in Viet Nam

over 100 species of wild and cultured fresh and to a lesser extent brackishwater fish. The primary causative agent of this disease has been confirmed as a fungus of the genus *Aphanomyces*. Combined losses from EUS in several Asian countries before 1990 were more than US$10 million; losses in Thailand alone from 1983–1993 were US$100 million. EUS continues to expand its range, the latest extension being into the rivers of the Indus in the Punjab of Pakistan. Outbreaks of ulcerative disease in *Brevoortia tyrannus* in the United States are very similar to EUS in Asia.

White spot syndrome virus (WSSV)

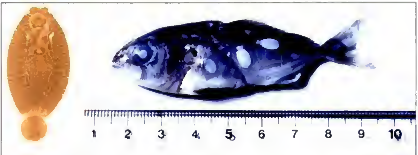
First reported in Taiwan Province of China and PR China between 1991-1992, then in Japan in 1993 from shrimp imported from China, this major viral disease of shrimp is now affecting almost all shrimp-producing countries in Asia and the Americas. WSSV has been officially reported from 10 countries in the Asia-Pacific Region including Bangladesh, PR China., Republic of Korea, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Viet Nam. As of 1999, WSSV has also been officially confirmed in at least nine countries in the Americas: Columbia, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru and the United States. Losses were in the range of more than US$400 million in China in 1993, US$17.6 million in India in 1994, US$600 million in 1997 in Thailand, and to a global estimate of US$3 000 million.

Viral encephalopathy and retinopathy (VER)

Among many other viral diseases, VER causes serious problems to grouper culture in the Asia-Pacific. VER was first reported in Japan in 1991 and has since been reported in Indonesia, Republic of Korea, Singapore and Thailand. The expanding trend in grouper aquaculture and related trade, without appropriate health management, increases the risk of introducing the pathogen into new localities and environments.

Neobenedenia girellae

One of the most commonly reported monogenean parasites of grouper and other marine fishes, this parasite was introduced to Japan along with importation of amberjack fry from Hainan, China and China, Hong Kong Special Administrative



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Right: Amberjack fry (Seriola dumerili) *infected with adult* Neobenedenia girellae, *on the day of arrival in Japan from China. Left: Stained whole mount of* Neobenedenia girellae.

Region. This parasite caused heavy infection and mortalities among flounder cultured in floating netcages in 1991 and of one-year-old amberjack in 1992 in Japan, where a total of 15 cultured marine fishes (e.g. groupers and flounders) and brackishwater cultured tilapia are susceptible. *Neobenedenia girellae* now causes serious problems in grouper culture in most countries of Southeast Asia.

Control measures

Measures to combat diseases of fish and shellfish have only recently assumed a high priority in many aquaculture-producing regions of the world. Development of such measures was stimulated by the serious socio-economic losses and environmental impacts caused by aquatic animal diseases, as well as by threats to food security and the livelihoods of vulnerable sectors of society. Many countries have improved their laboratory facilities, diagnostic expertise, control protocols and therapeutic strategies in order to better handle disease outbreaks. In addition, many farmers, especially in developed countries, have improved their capacity to respond quickly and effectively to emergent disease situations. They have also greatly enhanced their disease prevention awareness. Similar efforts towards strengthening aquatic animal health capacities in many developing countries are also being actively pursued, although the capabilities of many countries are still marginal.

INTERNATIONAL CODES

A number of international codes of practice, agreements and technical guidelines exist and are aimed, at least in part, at providing a degree of standardization for the protocols used to minimize the risks of disease associated with movements of aquatic animals.

These include:

- the World Organisation for Animal Health (OIE) Aquatic Animal Health Code and Manual of Diagnostic Tests for Aquatic Animals;
- the International Council for the Exploration of the Sea (ICES) Code of Practice on the Introductions and Transfers of Marine Organisms;
- the European Inland Fishery Advisory Council (EIFAC) Codes of Practice and Manual of Procedures for Consideration of Introductions and Transfers of Marine and Freshwater Organisms;
- the FAO's Code of Conduct for Responsible Fisheries (CCRF);
- the Convention on Biological Diversity; and
- the World Trade Organization's (WTO) Sanitary and Phytosanitary (SPS) Agreement.

REGIONALLY ORIENTED GUIDELINES

Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and the Beijing Consensus and Implementation Strategy

The "Technical Guidelines" were based on a set of guiding principles developed through a consultative process that involved representatives from 21 participating governments and technical assistance from regional and international experts on aquatic animal health. The Technical Guidelines describe a number of health management considerations aimed at minimizing the risk of disease spread via aquatic animal movements and were developed to:

- assist countries in the Asia-Pacific to move live aquatic animals in a way that minimizes the disease risks associated with pathogen transfer and disease spread, both within and across boundaries;
- enhance protection of the aquatic environment and biodiversity, as well as the interests of aquaculture and capture fisheries;
- provide a mechanism to facilitate trade in live aquatic species and avoid unjustifiable trade barriers based on aquatic animal health issues; and
- implement relevant provisions of FAO's CCRF and other international treaties and agreements (e.g. WTO's SPS agreement) applicable to the Asian Region.

The development of the Technical Guidelines took into account the different socio-economic and environmental circumstances of the participating countries in the Asia-Pacific Region, the diversity of infrastructures (in terms of trained expertise and institutional capability), the wide range of aquatic species being moved, the different reasons for such movements and the diversity of pathogens currently known.

DISEASE EMERGENCIES

With all efforts in place, disease emergencies still occur. They either result from the movement of exotics or introduced species, from simple trade-related movements or from an outbreak of an existing disease. In all cases, preparedness appears to be inadequate and the response to control is thus slow.

The present workshop attempts to address this issue with the view to develop an Asia Regional Strategy to deal with disease emergencies in aquatic animals.

OIE Asia-Pacific's experience in dealing with livestock disease emergencies in the Asia-Pacific

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ABSTRACT

Since 1924, the World Organisation for Animal Health (OIE) has worked to promote world animal health. The Regional Representation for Asia and the Pacific (OIE Tokyo) has worked to help the Member Countries deal with animal health improvement, including disease emergencies. The OIE Tokyo's experiences of emergency measures against terrestrial animal diseases serve as a good reference in order to prepare for aquatic animal disease emergencies. Three infectious animal diseases, foot and mouth disease (FMD), bovine spongiform encephalopathy (BSE) and highly pathogenic avian influenza (HPAI), have recently become a serious problem in the Asian Region. The lesson learned from these emergencies is the necessity to fight against the disease itself and, at the same time, to protect the livestock industry from international trade disputes. To fight against serious infectious diseases, it is important to establish cooperation systems between veterinary administrations and related ministries, departments and local governments. The OIE calls on the fishery authorities to make steadfast linkages with veterinary administrations to deal with aquatic animal disease emergencies. To protect the livestock industry from international trade disputes, it is indispensable to recover the disease-free status in accordance with international standards. The OIE has played important roles for aquatic animal health as well. The OIE Aquatic Animal Health Standards Commission develops the Aquatic Animal Health Code in line with the terminology of the Sanitary and Phytosanitary Agreement (SPS Agreement) of the World Trade Organization (WTO) to assure sanitary safety and international trade in aquatic animals and their products.

INTRODUCTION

The World Organisation for Animal Health (Office International des Épizooties, OIE) is an intergovernmental organization established in Paris, France in 1924 in order to promote world animal health. Since then OIE has worked as an informative and normative organization for animal diseases.

At the General Agreement on Tariffs and Trade (GATT) Uruguay Round trade negotiations, it was concluded that OIE be approved as one of the international standards-setting organizations by the World Trade Organization (WTO). Now, the OIE standards are used as judgment criteria in the WTO dispute settlement procedures.

In 1991, the OIE General Session decided to create the OIE Regional Representation for Asia and the Pacific in Tokyo, Japan (OIE Tokyo), aiming at providing its Member Countries with services adapted to the regional characteristics and more especially, to help them strengthen, in a coordinated manner and through the setting up of regional programmes, the surveillance and control of major diseases. Since then the OIE Tokyo Office has worked for the Member Countries in dealing with animal health improvement, including disease emergencies in this region. Some experiences with the diseases are given below as examples.

FOOT AND MOUTH DISEASE (FMD)

FMD is a typical OIE List A disease. OIE List A means transmissible diseases that have the potential for very serious and rapid spread, irrespective of national borders, that are of serious socio-economic or public health consequence and that are of major importance in the international trade of animals and animal products.

Reports are submitted to the OIE as often as necessary to comply with the OIE Terrestrial Animal Health Code (OIE, 2004a). The veterinary administration of an OIE Member Country has to send notification by telegram, fax or e-mail, within 24 hours, of any of the suspected or confirmed first occurrences or reoccurrence of a List A disease, if the country or zone of the country was previously considered to be free from that particular disease.

The OIE has been publishing the "Disease Free Country Lists" for specific diseases, namely FMD, rinderpest, contagious bovine pleuropneumonia and bovine spongiform encephalopathy (BSE).

In 1997, the OIE received the official notification of FMD outbreaks from Taiwan Province of China (Taiwan POC). The OIE immediately sent alert messages to all Member Countries and deleted the name of Taiwan POC from the list of FMD-free countries or zones, which was published through the Internet.

As a result of this change in the list of FMD-free countries or zones, trade partner countries, including surrounding countries, took necessary quarantine measures, including the import ban on animals and animal products from Taiwan POC and disinfection of tourists' shoes at airports and seaports. Importing countries that took the import ban notified their measures to the WTO. Veterinary administrations also instructed their police and coast guard departments to check the smuggling of animals and animal products more strictly.

Throughout the history of FMD accidents in the world, there are many cases where the FMD virus was transferred by wind, and sometimes it invaded into neighboring countries beyond channels. In the case of FMD in Taiwan POC, an island country surrounded by the sea, it was not demonstrated that the virus was transferred by wind. As a precautionary measure, the Japanese Government decided to kill all the pigs being raised in its small islands located just like steppingstones between Japan and Taiwan POC.

Lameness in small ruminants, such as sheep and goats, can be quite difficult to see in FMD

USDA

Between 1998 and 1999, there were no significant changes in the FMD situation of this region. But in 2000, the OIE received official notifications of FMD outbreaks from Kazakhstan, the Republic of Korea, Japan and Mongolia. The disease had been absent in the Republic of Korea since 1934, while in Japan the previous FMD outbreak dated back to 1908. OIE dispatched alert messages to all Member Countries again and deleted the names of the Republic of Korea and Japan from the list of FMD-free countries.

In May 2000, OIE Headquarters and OIE Tokyo sent experts to the Republic of Korea to investigate the origin of the FMD outbreak and to advise the government on the control measures to be taken.

In April 2001, OIE and FAO held the joint International Scientific Conference on Foot and Mouth Disease in Paris.

In the cases of Taiwan POC, the Republic of Korea and Japan, veterinary administrations set up infected zones and protection zones surrounding infected farms, and supervised and restricted the movement of animals in cooperation with local police departments. At first these three countries adopted the stamping-out policy, and then Taiwan POC and the Republic of Korea secondly adopted emergency vaccination.

In general, stamping-out is carried out under the authority of the veterinary administration, on confirmation of a disease. It involves the killing of the animals that are affected and those suspected of being affected in the herd and, where appropriate, those in other herds that have been exposed to infection by direct animal to animal contact or indirect contact likely to cause the transmission of the causal pathogen. All susceptible animals on an infected premise should be killed and their carcasses destroyed by burning, burial or any other method that will eliminate the spread of infection through the carcasses or products of the animals killed.

In those countries, carcass disposal work was undertaken by veterinary administrations assisted by local government officers and sometimes by national army soldiers. However, it was very difficult to find appropriate places to bury carcasses, and veterinary administrations faced hard negotiations with mayors and governors.

The OIE strongly recommends that veterinary administrations exercise the simulation of disease prevention, including establishment of cooperation systems with other related ministries, departments and local governments, and the secured plan of carcass disposal.

When a country or a zone in the country was previously considered to be free from FMD, the Chief Veterinary Officer would, with necessary documents including results of monitoring and surveillance, apply to the OIE to declare freedom from the disease.

Japan began its effort to recover the FMD-free status. In September 2000, when more than three months had elapsed since the last case was observed, stamping out without vaccination had been implemented, and serological surveillance had detected no signs of existing FMD virus, Japan submitted its formal application for FMD-free status to the Director General of the OIE. Its application was evaluated by the OIE FMD and Other Epizootics Commission. By the end of the month, Japan regained its status as a FMD-free country.

In the Republic of Korea, stamping out was applied in the affected farms and farms in the vicinity. Given the severity of the clinical signs observed in cattle, emergency vaccination was applied to cattle in the protection zones around the outbreaks. As no other outbreaks occurred, the movement restrictions that had been imposed were lifted in May 2000. However, the emergency vaccination (given to nearly 600 000 animals in over 11 052 farms) delayed recovery of its disease-free status. Finally, in May 2004, the Republic of Korea regained its status as a FMD-free country.

Taiwan POC has to date not recovered disease-free status because of its nationwide vaccination practices.

For other FMD-infected countries in the region, the OIE carries out the South-East Asia FMD Control Campaign (so-called SEAFMD), which has been successfully progressing. SEAFMD aims at establishing the status of a FMD-free area to be accepted internationally, and the participating countries are using the OIE Code and Manual (OIE, 2004a, 2004b) as their guidelines.

The SEAFMD Campaign serves as a good model for the future establishment of the Global Framework for Progressive Control of Trans-boundary Animal Diseases (GF-TADs). The joint OIE/FAO initiative of the GF-TADs project will strongly assist Member Countries in establishing control programmes against specific animal diseases on a regional basis.

BOVINE SPONGIFORM ENCEPHALOPATHY (BSE)

BSE is considered as a kind of zoonosis (in human cases, it is known as variant Creutzfeld-Jakob disease) and classified as an OIE List B disease. OIE List B means transmissible diseases that are considered to be of socio-economic and/or public health importance within countries and that are significant in the international trade of animals and animal products. Reports are normally submitted to the OIE once a year, although more frequent reporting may in some cases be necessary to comply with the OIE Terrestrial Animal Health Code. So far, to meet the demand of Member Countries, the OIE decided to publish the "Disease Free Country List" for BSE.

In recent years, many Member Countries submitted formal applications for BSE-free status to the Director General of the OIE. These applications were evaluated by an ad hoc group of experts on BSE that had been set up, and also by the Scientific Commission. However, the conclusions did not come out easily, because the OIE cannot take responsibility for publication of a country's inaccurate disease status based on inaccurate information or change in epidemiological status or other significant events that were not promptly reported to the Central Bureau. After accurate and complete data were received, during the 72nd OIE General Session held in May 2004, the Director General established a list of BSE provisionally free countries or zones in accordance with the chapters of the Terrestrial Animal Health Code. The first list of provisionally free countries included Argentina, Uruguay, Iceland and Singapore.

In Asia and the Pacific, so far the OIE has received official notifications of BSE outbreaks only from Japan. In 2001, Japan reported three cases of BSE for the first time; two cases were reported in 2002 and one atypical BSE case in 2003.

In Japan, repeated reporting of BSE cases in various ways by mass media contributed to drastic reduction in consumption of not only domestically produced beef but also of imported beef. When a serious infectious disease occurs, sometimes various rumors circulate and unconfirmed reports are accepted as facts. Producers, government officials, policy-makers, exporters, importers, consumers etc. ask for official information provided by a responsible source.

The OIE Regional Representation for Asia and the Pacific based in Tokyo held the Consultation Meeting on BSE Public Awareness in Chiang Mai, Thailand in October 2003, in collaboration with the FAO-Animal Production and Health Commission for Asia and the Pacific (FAO-APHCA) and the Department of Livestock Development, Thailand (DLD). The Consultation Meeting drafted three different types of model information papers for public awareness. The pamphlet for policy-makers aims at facilitating legislation and funding of measures, that for veterinary services is aimed at understanding the basis for implementation of various BSE programmes, and that for consumers, at understanding what BSE is and what is safe. The model information papers will be modified and translated into local languages in the respective countries in the region, where appropriate.

OIE Tokyo has also held the Regional Workshop on BSE Diagnosis and Surveillance in collaboration with FAO-APHCA and DLD since 2001. The purpose of the Hands-on Training Workshop was to train laboratory staff from selected countries in Asia and the Pacific.

HIGHLY PATHOGENIC AVIAN INFLUENZA (HPAI)

Control and management of poultry movement is key in the fight of transboundary animal diseases such as avian influenza

FAO

HPAI is a typical zoonosis and classified as an OIE List A disease. Since the end of 2003, the OIE has received notifications of HPAI outbreaks from many Asian countries and areas.

In the Republic of Korea, HPAI virus subtype H5N1 was isolated from samples collected from broilers and ducks in December 2003.

In 2004, the OIE received official notifications of HPAI confirmation from Viet Nam, Japan, Taiwan POC, Thailand, Cambodia, Hong Kong Special Administrative Region and Laos in January, and from Indonesia and the People's Republic of China in February. Viet Nam reported outbreaks in three parent-stock farms for broilers that had started in December 2003. This was the first occurrence of HPAI reported in Viet Nam. Indonesia reported several outbreaks of HPAI initially confirmed in December 2003. The OIE immediately dispatched alert messages to all Member Countries.

Before the OIE received official notifications from the governments of the Member Countries, various rumors had already circulated in the mass media. Therefore, people asked for official information provided by a responsible source as quickly as possible.

The OIE receives official disease notification with the signature of the Chief Veterinary Officer directly from a relevant Member Country. Furthermore, the OIE collects animal health information based on the active search policy. The information thus collected, including nonofficial information from scientific journals, local newspapers, TV news etc., is systematically evaluated before deciding whether to verify it with the Chief Veterinary Officer of the relevant Member Country.

OIE information is recognized and used as official information around the world. Therefore, during the avian influenza crisis, more than 40 000 people visited the OIE Web site during only one week. OIE information is commonly used as official information by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) in their Web sites

In February 2004, in Bangkok, OIE and FAO jointly organized the Emergency Regional Meeting on Avian Influenza Control in Animals in Asia in collaboration with WHO. The meeting discussed various areas and recommended important activities to be undertaken for short- and long-term disease control strategies, including networking of the countries and a future Global Framework for Progressive Control of Trans-boundary Animal Diseases (GF-TADs) project. HPAI will be selected as one of serious transboundary animal diseases to be targeted by GF-TADs.

Laboratory testing for highly pathogenic avian influenza in Southeast Asia

FAO

CONCLUSIONS

The lessons learned from the above-mentioned emergency experiences are as follows:

- In order to perform an official notification, and in order to carry out stamping-out measures accompanied by compensation, implementation of diagnosis in accordance with international standards is indispensable; and
- In order to recover the disease-free status, implementation of surveillance and monitoring in accordance with international standards is indispensable.

OIE has been widely considered as an international and intergovernmental organization for terrestrial animal health, but has played important roles for aquatic animal health as well. The OIE Headquarters and the Regional Representation for Asia and the Pacific based in Tokyo are working with Member Countries to collect and disseminate aquatic animal health information and to organize meetings such as the International Conference on Risk Analysis in Aquatic Animals, the International Symposium on Koi herpes virus Disease and Regional Hands-on Workshop on Diagnosis and Surveillance of Aquatic Animal Diseases.

One of the OIE Specialist Commissions, namely the OIE Aquatic Animal Health Standards Commission, develops the Aquatic Animal Health Code (OIE, 2004c) in line with the terminology of the Sanitary and Phytosanitary Agreement (SPS Agreement) of the WTO to assure the sanitary safety and international trade in aquatic animals and their products. Fortunately no serious arguments on international trade of aquaculture products have so far been brought for WTO dispute settlement as SPS issues.

The aquaculture sector has been growing rapidly in Asia and Pacific and now this region is producing approximately 79 percent in value and 88 percent in volume of aquaculture products worldwide. However, we are now confronting the threat of transboundary aquatic animal diseases such as Koi herpes virus (KHV). To protect aquaculturists in this region not only from serious infectious diseases but also from future international trade disputes, the OIE Regional Representation for Asia and the Pacific calls on the fishery authorities in Member Countries to make steadfast linkages with veterinary administrations and to take advantage of OIE information and standards to deal with of aquatic animal disease emergencies.

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Emergency preparedness of aquatic animal diseases: Norwegian experiences

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ABSTRACT

Outbreaks of disease may have large consequences for aquaculture production and thus significant impact on the economy at the local, regional and national levels. This paper describes the key elements in emergency preparedness based on Norwegian experiences. Norway has had fish disease legislation since 1968. Management of disease emergencies is a core responsibility of governmental authorities based on appropriate legislation. Regulations on notification, diagnosis, epidemiology and restrictions on trade as well as fallowing and disinfection are important tools in disease management. An effective organization and adequate personnel resources, as well as competent diagnostic laboratories, are also key elements. Furthermore, emergency preparedness includes disease prevention and control through implementation of factors such as movement control, sanitary slaughter and zoning. With the tools described, it is possible to handle emergencies in aquaculture optimally.

INTRODUCTION

Over the last decades, emerging or serious diseases such as viral haemorrhagic septicaemia (VHS), infectious haematopoietic necrosis (IHN), infectious pancreatic necrosis (IPN), viral nervous necrosis (VNN), epizootic ulcerative syndrome (EUS) and many others have been diagnosed in feral and farmed fish populations in different parts of the world where they were previously unknown to occur.

Outbreaks of severe disease may have dramatic consequences for aquaculture production and thus have significant impact on the economy at the local, regional and national levels. The losses may be due to reduced production, increased labour costs and increased expenses due to medication. In addition, restrictions on trade are becoming increasingly important as an economic consequence. Furthermore, diseases in farmed aquatic animals may affect the environment in different ways, for instance by transmission of infectious disease to the wild fish population, which may have a negative impact on the wild stock, e.g. infection of *Gyrodactylus salaris* in Norwegian rivers.

Gyrodactylus salaris *of salmon*

The food safety aspect of diseases of aquatic animals is less important than for diseases in terrestrial animals, as few aquatic animal diseases have true zoonotic potential. However, as microbial diseases in farmed fish are often treated with antibiotics, both residues and microbial resistance against antibiotics may be undesired effects of fish disease.

Effective emergency management is therefore crucial in order to reduce the economic, social and environmental impacts of serious diseases in aquaculture, and many countries, including Norway, have thus initiated emergency programmes for the control and/or eradication of such diseases (Folkestad and Torgersen 1999, Håstein, Hill and Winton 1999). The efficiency and success of such programmes are dependent on rapid initiation of the necessary measures/actions.

DISEASE AETIOLOGY

The most serious diseases in aquatic animals are caused by micro-organisms (bacteria, fungi, viruses, parasites). Such diseases may be introduced to a region/country, while others may already exist, but show a rapid increase in incidence due to predisposing factors such as high population density, bad water quality etc. The nature of the diseases, including their contagiousness and severity, may, however, vary significantly. Non-infectious diseases due to toxic components or nutritional factors may also have severe impact in aquaculture. Diseases with complex aetiology, involving both microorganisms as well as various predisposing factors, are becoming more common in some countries with a developed aquaculture.

RESPONSIBILITY

The management of disease emergencies remains a core responsibility for governmental authorities. The government should provide the necessary legislation and should also have an important role in leadership and intellectual input in such work. However, cooperation with the private sector, for example industrial organizations, local enterprises and farmers, is also an important element in the management of emergencies.

In Norway, the Ministry of Agriculture has had responsibility for aquatic animal diseases since 1968. As of 2004, the Ministry of Fisheries took over this responsibility as part of the reorganization of legislation related to food safety and the health of animals, aquatic animals and plants. A new agency, the Norwegian Food Safety Authority, has responsibility for implementing the Act and regulations given in pursuance of the Act.

LEGISLATION

Appropriate legislation is a fundamental instrument in emergency management. All biosecurity measures must have a legal basis. This includes disease notification, disease diagnosis or suspicion of disease, collection of specimens or epidemiological information, restrictions on trade or movement, disposal and decontamination of material, and cleaning and disinfection of premises.

The statutory definition of action to be taken is one of the most significant legal steps for disease control in aquatic animals and may have tremendous implications for on-farm management practices aimed at disease control. Depending upon the classification and importance of a notifiable disease, different management practises may be laid down by law to achieve sufficient disease control.

In Norway, fish disease legislation was established in 1968 due to the introduction of serious diseases such as viral haemorrhagic septicaemia (VHS) and furunculosis into Norway by imports of live rainbow trout (*Oncorhynchus mykiss*) from Denmark (Håstein, Holt and Krogsrud 1968, Holt and Håstein 1970).

The first "Fish Disease Act" covered only diseases of freshwater fish, including anadromous and catadromous fish species as well as freshwater crayfish. The reason for this was that diseases in salmonid species and freshwater crayfish were of major importance, and farming of other species had not been considered at that time.

In 1990, an interim Act covering all aquatic organisms, including marine species, was adopted. However, as regards marine aquatic organisms, only those kept under culture conditions were covered. The intention was to replace this interim Act by a permanent Act in 1992, but this permanent Act did not come into force until 1997.

As of January 2004, a new legislation, the so-called "Food Act", covering all aspects of animals and aquatic animals from fiord and pasture to the table was introduced (Anon., 2004a).

Several regulations have been introduced in pursuance of the acts referred to above, and these regulations have been improved over the years since 1968 until today. Some 36 regulations are now in force in pursuance of the current Act.

The "Food Act" is an enabling act as regards control of animal health and gives wide authority to prevent, eradicate and keep diseases and infective agents in aquatic animals under surveillance. The Act also includes particular powers to ensure eradication of exotic diseases.

ORGANIZATION

An effective organization with functional responsibilities for preparedness is the basis for the work of the governmental authority. In addition to a central unit with direct link to the policy decision-makers within the political system, including those at the ministerial level, there should be a regional and a local organization with professional and paraprofessional personnel. The command principles between the levels of the organization, as well as the relationship to institutions providing scientific and technical support, should be well defined. As cooperation with the industry and information to the public are important for the success of any emergency management, a well-organized communications system should be integrated into the organization.

In Norway, the Norwegian Food Safety Authority consists of three levels: a Central Unit, eight Regional Offices and 64 District Offices covering the entire country. In emergency situations, the District Offices have the main responsibility for immediate implementation of measures such as:

- restrictions on a farm on suspicion;
- confirmation of diagnosis of the notifiable disease in question;
- provision of any supplementary information/changes in earlier information; and
- repeal of restrictions.

The tasks of the District Offices include reporting to the regional and central authorities.

PERSONNEL RESOURCES

Depending on the infrastructure within a country, a national and/or a regional (local) emergency team (disease experts, operational team, administrative personnel) should be established in order to cope with outbreaks of serious diseases.

In Norway, we have a network of veterinarians, fish health biologists and diagnostic laboratories that may be involved in implementation of actions necessitated by an emergency disease outbreak. With such a good infrastructure, it has been relatively easy to implement any information and measures to be taken in case of an outbreak of an unknown disease.

Fish health training

TORE HÅSTEIN

TRAINING PROGRAMMES

In order to maintain the state of readiness, announced and unannounced exercises in handling exotic diseases or any serious disease should be carried out for personnel at all levels that will become involved in the different aspects of control of aquatic animal diseases. For fish health personnel, this must include updated information on the disease in question, epidemiology of the disease, sampling and diagnostic methods, new disinfection procedures etc. Specific training programmes should also involve people from the fish farming industry. The responsibility for these training programmes should involve the responsible authorities at the central, regional and local levels. Norway has good experience with such types of training programmes.

EQUIPMENT AND FACILITIES

Handling of emergency situations requires necessary equipment and supplies. These include communication equipment and maps covering coastal and continental areas of the country, as well as equipment for necropsy and the introduction of sanitary measures. Furthermore, routines for how to issue warning notices to inform the public relating to restricted access to the premises in question, as well as access to transportation units (boats, vehicles) are needed and whether sanitary slaughtering, etc. is required. All this will have to be a part of a contingency plan.

MANUAL

Preparation for emergency situations is crucial for success during a disease crisis. A simple but thoroughly written plan describing responsibilities and activities in case of a disease outbreak is a major element in the emergency management. Professional and paraprofessional personnel with theoretical and practical training must be available in order to carry out the activities at the central and regional units, as well as on the local level.

Although Norway, presently has in force only a contingency plan for infectious salmon anaemia (ISA) (Anon., 2004b), the principles laid down in this plan have also been used to bring other serious diseases under control.

DIAGNOSTIC LABORATORIES

Rapid, reliable and effective diagnostic work should be carried out by national or provincial laboratories designated for such purposes by the competent authority, as this may be essential for a successful outcome of a crisis. Diagnoses of serious disease should, if necessary, be confirmed by an international reference laboratory for the disease in question.

Each country should thus establish a national fish disease reference laboratory that should have a key responsibility for aquatic animal diseases and with well-qualified personnel, facilities and equipment in order to handle a crisis. This responsibility

Bacteriological analysis

TORE HÅSTEIN

should include reference functions for regional and local laboratories with official or private funding. A decentralized laboratory structure is especially essential in countries with large fish populations that are distributed over large geographical areas.

The expertise of the laboratories should include scientifically based diagnostic procedures in addition to research, but also competence in preventive medicine and emergency management is needed. Descriptive and analytical epidemiology and risk assessment are areas with increasing significance in emergency situations in aquaculture and should be part of the scientific advice given to the authorities by the laboratories.

TORE HASTEIN

Microbiology laboratory

New methods for diagnostic work and surveillance are under continuous development, and the laboratory should have the competence and capacity to be updated on the international progress in diagnostic procedures.

Pathology is considered as the most essential area of competence for an aquatic animal health laboratory with diagnostic responsibilities. The clinical signs in diseased aquatic animals are often vague and non-specific, and necropsy is the major method for diagnosing diseases. The post-mortem lesions should be supported by histological examinations. Techniques based on histochemistry and immunological methods may contribute to a more precise diagnosis, including the aetiology of a given disease.

Necropsy should be performed in an equipped laboratory with good technical support. However, if transport to a pathological laboratory is long and costly, necropsy in the field may be an alternative. If performed by skilled personnel, a preliminary diagnosis may be obtained, creating a basis for control measures. Furthermore, samples may be taken, preserved and shipped to regional or central laboratories for further examination and confirmation.

Bacteriological examinations should be available in any diagnostic laboratory. Diagnostics for viral diseases requires cell or tissue cultures and personnel with special expertise. Viral isolation should consequently be performed in the central and most specialized laboratories.

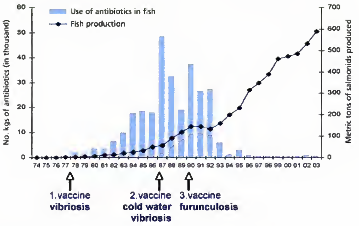
Methods based on molecular biology are becoming more and more used as part of the diagnostic work in bacteriology, virology, mycology and parasitology. These techniques offer great advantages in sensitivity and speed, but the analyses should take place in well-equipped laboratories due to the risk of false positive and negative reactions.

Over the years, the National Veterinary Institute has built up its expertise in all the fields mentioned above and functions as a national reference laboratory for Norway, giving scientific advice to the authorities based upon research, surveillance programmes and the results of diagnostic investigations.

COMMUNICATION

Since most aquatic animal diseases constitute no human health hazard, it may not be necessary to direct special efforts towards public education. Nevertheless, it may be worth while to prepare some press releases giving definite information on the disease in question to avoid rumours and incorrect information. Such information should clearly state that the disease does not represent any health risks to humans.

However, from an aquatic animal disease aspect, there is a need for emergency information between the field and the international society when a listed disease has been diagnosed. Thus, neighbouring countries should be informed, in addition to international organizations (i.e. the European Union (EU), the Network of Aquaculture Centres in Asia-Pacific (NACA), the Office International des Épizooties (OIE) etc.).



Effect of vaccination on the use of antibacterials in Norway 1974 - 2003

DISEASE PREVENTION AND CONTROL

Emergency preparedness for aquatic animal diseases also includes establishment of disease prevention and control measures. Since production of animal protein has to be sustainable, the preventive measures to be used have to be acceptable from a biological and environmental point of view. Vaccination is now the single most important measure for prevention of bacterial diseases in farmed fish, especially in salmonid fish (Håstein, Gudding and Evensen, 2005).

In Norway, the use of vaccination as a preventive measure started as early as 1977, and regulations regarding vaccination of fish were established in 1983. These regulations were updated in 1999 (Anon., 1999). Only vaccines authorized by the Norwegian Medicinal Authority are allowed to be used. The vaccination policy in Norway has had a large influence on the use of antibacterials.

Effective control of an emerging disease may be obtained through implementation of measures such as movement restriction, stamping out, sanitary slaughter and establishment of control and surveillance zones.

CONCLUSIONS

Based on the experiences gained in Norway after some 35 years of disease control in aquatic animals, we still have to live with certain diseases, but the legislation and regulations have given us the necessary tools to handle emergency crises in an optimal way. Since the infrastructure and disease situation may vary from country to country and between regions, it is important that the regulations are as flexible as possible in order to retain sufficient precautions should an emergency situation occur.

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Response to mass mortality of carp: an Indonesian experience[1]

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ABSTRACT

Since March 2002, Indonesian carp culture has faced a serious epizootic that has caused severe economic loss and significant social impact. As of December 2003, losses were estimated at US$15 million, with total fish mortality of up to 80-95 percent. The disease outbreaks affected koi and common carp (*Cyprinus carpio*) populations of all ages and sizes cultured in different grow-out facilities (ponds, lakes, cages etc.), regardless of stocking density. Epidemiological observations indicated that the first outbreak occurred in imported koi carp that had just been transported from Surabaya to Blitar, both in East Java. The heavy rain prior to the initial outbreak indicated the possibility of an environmental triggering factor, such as temperature. Based on the history, clinical signs, epidemiological features, histopathological changes, results of experimental infection, PCR detection of naturally and experimentally diseased fish, and analysis of DNA sequence, it is confirmed that Koi herpes virus (KHV) was involved in this serious outbreak. To prevent the spread of the disease to other islands, the Government of Indonesia declared the islands of Java and Bali as isolated areas infected with the disease, and movement of koi and common carps from Java to other islands has been restricted to quarantined animals. The government has also taken measures to reduce the possible re-introduction of the disease through importation of koi and common carps into the country. This paper includes information collected in July 2002 during the initial investigation conducted by the Emergency Disease Control Task Force on a Serious Disease of Koi and Common

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Initially, many factors were speculated to be responsible for this new outbreak, including water pollution, contaminated feed and bacterial infection. NACA's Task Force found that koi herpesvirus (KHV) might have played a role in the mass mortalities, and since then, Indonesian scientists have used the term KHV. However, the Task Force recommended that this serious outbreak be called "mass mortality of koi and common carp" until a clear association with KHV could be established (NACA, 2002). During the International Workshop on Koi Herpesvirus held in London in February 2004, it was agreed that the cause of the Indonesian outbreak was KHV (see Crane, Sano and Komar, 2004).

Carps in Indonesia organized by the Network of Aquaculture Centres in Asia-Pacific (NACA) and partners, results of the on-going work undertaken by the National Disease Task Force, and the Food and Agriculture Organization of the United Nations' (FAO) follow-up assistance through a Technical Cooperation Project.

INTRODUCTION

Aquaculture plays an important role in rural development, provides a source for export earning and has proved to be a leading sector in economic growth in Indonesia. Freshwater, brackishwater, and marine cage culture still have an opportunity to be expanded and developed. However, since March 2002, Indonesian carp culture has faced a serious epizootic that has caused severe economic loss and significant social impact. The epizootic nature of the disease and its potential for spread to neighbouring Asian countries, the current economic impact and the potential threat to the production of this important foodfish, and the potential trade and economic implications are significant and require urgent implementation of containment and control procedures.

Responding to an official request from the Government of Indonesia, immediate assistance was provided by the Network of Aquaculture Centres in Asia-Pacific (NACA) and partners, by fielding an Emergency Disease Control Task Force on a Serious Disease of Koi and Common Carps in Indonesia consisting of three fish health experts in July 2002. The Task Force provided several key recommendations to improve the fish health status of Indonesia and to reduce possible disease outbreaks. The Task Force report provides supportive evidence of possible Koi herpes virus (KHV) infection, the confirmed aetiology of which is yet to be found. To further assist Indonesia in finding a resolution to this emergency situation, the Food and Agriculture Organization of the United Nations (FAO) approved emergency assistance to the Government of Indonesia through a Technical Cooperation Project – TCP/INS/2905(A) entitled "Health Management in Freshwater Aquaculture", which commenced on 10 January 2003.

This paper includes vital information collected in July 2002 during the initial investigation conducted by the Emergency Task Force organized by NACA and partners, results of the on-going work undertaken by the National Disease Task Force, and FAO's follow-up assistance through a Technical Cooperation Project.

EMERGENCY RESPONSE

The Government of Indonesia immediately responded to the outbreak of mass mortality of koi and common carp. Initial actions taken included announcing the occurrence of the disease outbreak to stakeholders, issuing a regulation restricting the movement of diseased fish, organizing the National Disease Task Force, reporting the outbreak to the Office International des Épizooties (OIE) (Rukyani, 2002), and seeking assistance from international agencies that lead to the formation of NACA's Task Force and an FAO Technical Cooperation Project. In addition, the government also provided various assistances to affected carp farmers.

Koi carps are highly valuble ornamental fish

AGUS SUNARTO

Rules and regulations

The first episode of the outbreak in koi occurred in March 2002 in Blitar, East Java. On 17 May 2002, the Director General of Aquaculture (DGA) issued Circulation

Letter No. 1874 pertaining to the disease outbreak in koi and common carp. The announcement letter was circulated to provincial governments, fisheries offices and other stakeholders. As the outbreak was escalating and spreading to new areas, the government organized a National Disease Task Force (DGA's Letter No. 2101 dated 4 June 2002). The main mandate of the National Task Force is to control the outbreak and to minimize the economic losses.

AGUS SUNARTO

Common carps are important food fish

Based on the recommendation of the National Task Force, the government declared Java Island as an isolated area of the disease, strictly prohibited the movement of koi and common carp from Java to other islands, and permitted the importation of koi and common carp only from KHV-free countries (DGA's Letter No. 2317 dated 14 June 2002 and Ministerial Decree No. 28 dated 2 July 2002). The regulations were issued in order to protect the country from re- introduction of the disease, to prevent wider spread of KHV and to minimize losses in common carp and koi culture. However, due to the restriction on movement of koi and common carp, there was an over-supply of common carp on Java Island.

To solve this problem and due to social pressure, the government issued Ministerial Decree no 40 dated 3 October 2002. The degree declared Java and Bali islands as an isolated area of Koi herpes virus (KHV) and specified that the movement of koi and common carp from Java and Bali to other islands should follow a quarantine check for KHV. However, because trucks with live fish often cross the strait without reporting to the checkpoint office, the application of Decree No. 40 has not been effective. Such trucks are usually without documents or certificates of fish health. At Merak, the checkpoint for the movement of live fish from Java into Sumatera Island is not equipped with simple laboratory equipment. Live fish traffic, especially carp, destined to Sumatera, involves around 5-10 trucks per day. The live carp transported to Sumatera originate from KHV-infected areas, i.e. Cirata Reservoir, Sukabumi, Subang, Pandeglang and Jatiluhur. Thus, Merak is a strategic point for the spread of fish disease from Java to Sumatra, since it is the most convenient entry point for inter-island live fish movement between the islands. The spread of KHV disease to the whole of Sumatera through the Merak Check Point is just a matter of time unless there is other policy to stop the infected live fish movement to Sumatera. If Decree No. 40 is to be effective, officers at key checkpoints must be given the necessary infrastructure, authority and manpower to fully enforce regulations (Arthur, 2003). The provincial and district authorities of uninfected regions should be encouraged to regulate the movement of live carp from Java to their regions (Prayitno, 2003). However, the disease spread to Sumatera Island in January 2003 (Yuasa *et al.*, 2004).

Governmental assistance

Besides issuing rules and regulations soon after the outbreak, the government also provided assistance to affected carp farmers. This included new broodstock, disinfectants, diagnostic services, training and consultancies. A website (www.ditkeskanling.go.id) was also established to provide information on the outbreak and fish health management in general. Intensive information dissemination was also undertaken to raise awareness and inform the public sector about KHV and the relevant information available at that time.

Fulfilling international obligations

As a member of the international community, the Government of Indonesia has fulfilled its obligation to report important diseases to the Office International des Épizooties (OIE). A report of the KHV epidemic was sent to OIE on 26 June 2002 (Rukyani, 2002). Since then, a regular report on the KHV outbreak has also been sent to OIE through the NACA/OIE/FAO Asia-Pacific Quarterly Aquatic Animal Disease Reporting System.

NACA's Task Force

In 20 June 2002, Dr. Fatuchri Sukadi, Director General of Aquaculture, Ministry of Marine Affairs and Fisheries, requested assistance for the solution to the outbreak to NACA. NACA's response was to organize the Emergency Disease Control Task Force on a Serious Disease of Koi and Common Carps in Indonesia, subsequently referred to as NACA's "Task Force", in cooperation with the Australian Centre for International Agricultural Research (ACIAR) and the Aquatic Animal Health Research Institute (AAHRI). The Task Force, which consisted of international and national experts and a number of participating laboratories and organizations, conducted an emergency assessment of the disease situation in July 2002 through field observations (i.e. field visits, interviews with local/district officials and farmers) and laboratory examinations (e.g. histopathology and virology, including use of polymerase chain reaction (PCR), and electron microscopy (EM)) of collected samples).

The Task Force collected vital information about the disease occurrence, epidemiological perspective and provided supportive evidence of a possible KHV infection, the confirmed aetiology of which is yet to be found. The Task Force findings recommended that this serious outbreak of koi and common carp be called "Mass mortality of koi and common carp (MMKC)" until a clear association with KHV or another specific disease can be established. The Task Force also provided several key recommendations for improving the fish health status of Indonesia and reducing possible disease outbreaks (NACA, 2002).

FAO's Technical Cooperation Programme

As follow-up to the recommendations of NACA's Task Force and in response to a request from the Government of Indonesia, FAO immediately provided emergency assistance through a Technical Cooperation Project "Health Management in Freshwater Aquaculture" (TCP/INS/2905(A)), to find resolution to this disease emergency. The project was set up to:

- strengthen diagnostic and control capabilities within the responsible state agencies for major diseases of cultured freshwater fish, including koi and common carp;
- improve capacity for vulnerable rural aqua-farmers to face future outbreaks in their culture systems;
- enhance national regulatory frameworks and legislation, improve biosecurity measures and strengthen national disease surveillance and reporting to reduce the risk of movement of pathogens, both nationally and internationally, through movement of live animals; and
- develop and implement Indonesia's National Strategy on Aquatic Animal Health Management.

Under the project, various issues on fish health management in Indonesia were addressed. These included review of policy and legislation, enhancement of the national regulatory framework and development of a national strategy on fish health management. Other related issues on fish health management such as strengthening diagnostic and control capability; improving surveillance, monitoring and disease reporting systems; human resource development and public awareness are being addressed. The project is also concerned with the identification and confirmation of the aetiological agent of the disease and is looking for assistance from international laboratories.

Legislation: The major accomplishments arising from the consultancy on fish health legislation include:

- a one-day national workshop on import risk analysis (IRA);
- a workshop on legislation on fish health management;
- review and revision of the National Strategy on Fish Health Management;
- identification and brief summary of the contents of national legislation dealing with fish health management and;
- recommendations with regard to future activities.

It should be noted that the short duration of the consultancy, combined with the complicated and extensive nature of the Indonesian legislation on fish health and the complicated structure of the Indonesian fish quarantine service made it impossible to undertake anything more than an initial and incomplete examination of the issues surrounding these sectors. Recommendations are made for more detailed future reviews in these two important areas (Arthur, 2003; Prayitno, 2003).

Fish health management: A consultancy was undertaken to understand the fish health management practices by stakeholders. Below is summary of the findings based on the report of the consultants (Shariff, 2004; Pasaribu, 2004). Investigations revealed that disease outbreaks were a common phenomenon due to the following:

- lack of appropriate infrastructure and trained personnel;
- lack of stakeholder knowledge regarding good fish health management practices;
- lack of stakeholder understanding of the complexity of fish health management due to an array of potential sources of disease outbreak;
- farming communities spreading diseases through movement of apparently healthy fish that are carriers of disease;
- lack of manpower and funds for extension services to reach the fish farming community;
- lack of understanding on the part of officers providing extension service of the complex issues related to fish disease outbreaks and their inability to communicate effectively with the fish farming community;
- in some cases, lost faith by the farming community in the extension services, as the information provided is considered unreliable;
- poor infrastructure at fish breeding centers and live fish markets, which are centers for distribution of disease;
- even when KHV had caused severe economic losses to farmers, movement of fish suspected to be infected with KHV still continues freely, spreading it to new localities;
- poor networking among the various agencies related to the aquaculture industry; and
- insufficient collaboration among the various institutions for research in fish health.

The major accomplishments arising from the consultancy include:

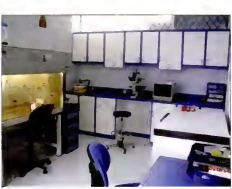
- identification of fish health management problems faced by farmers and their needs to overcome these problems;
- development of a module for fish health management practices that can be used as standard teaching material for fisheries officers and fish farmers;
- conducting national training programmes on fish health management for fisheries officers and fish farmers respectively; and
- recommendations with regard to future activities on fish health management.

Epidemiology: The major accomplishments arising from the consultancy are as follows:

- field investigation to affected and unaffected common carp production areas to formulate prevention strategy;
- assessments of the disease reporting capabilities and communication infrastructure;
- description the general characteristics and components of an aquatic animal disease surveillance system;
- national survey on the geographic distribution and progression of KHV in the country;
- construction of a web-based information system on fish health management with special emphasis on a disease reporting system (www.ausvet.com.au/indofish); and
- recommendations with regards to future activities on research, information system, epidemiology and control of KHV (Cameron, 2003; Rukyani, 2003).

Virology: Equipment, facilities and human resources were reviewed at major laboratories involved in fish health management, and fish disease diagnostics laboratories were visited in order to evaluate current diagnostic capabilities, with particular reference to fish virology. The major accomplishments arising from the consultancy are as follows:

- a total of 13 major laboratories were visited, with a view to setting up a national center for virology;
- assistance was given to a number of laboratories visited in terms of advice on laboratory design, equipment use and requirements for fish disease diagnostics and research;
- a National Virology Unit was established at the Fish Health Research Laboratory (FHRL), which is the first of its kind in the country;
- a laboratory manual was developed for the operation of the virology unit that can be used as standard operating procedures (SOP) for other virology laboratories;
- a three-day training workshop on fish virology was conducted for staff from 17 major laboratories in Indonesia;
- an Inter-laboratory Network (ILAN) was established in order to facilitate information exchange among laboratory workers; and
- recommendations were made with regard to the future development and activities to sustain the function and operation of the National Virology Unit (Millar, 2003; 2004; Sunarto, 2004).



National virology unit of the Fish Health Research Laboratory of Indonesia

AGUS SUNARTO

Surveillance and information system: These issued were addressed mostly by the consultant in epidemiology. The major accomplishments arising from the consultancy are as follows:

- description of the general characteristics and components of an aquatic animal disease surveillance system; and
- construction of a pilot web-based information system on fish health management in Indonesia, with special emphasis on disease reporting system by Dr. Angus Cameron (www.ausvet.com.au/indofish).

A website of the Directorate for Fish Health and Environment (www.ditkeskanling.go.id) was also set up to provide general information on fish health management. Indofish is being placed in the directorate's website.

Human resource development: Under the project, five training workshops on legislation, epidemiology, virology and fish health management for fisheries officers and key farmers were completed. Four persons attended two-week overseas training at the Aquatic Animal Health Research Institute (AAHRI) in Bangkok, Thailand. The project termination workshop was expanded to an FAO regional workshop conducted on 21-23 September 2004. Dissemination of information regarding fish health management including technical guidelines for KHV and whitespot syndrome virus (WSSV) and a poster for import risk analysis (IRA) were produced and distributed to stakeholders.

HISTORY OF THE OUTBREAK

The history of the outbreak including the first three episodes was chronologically described by Sunarto *et al.* (2002). The first episode of mass mortalities of cultured koi carp was recorded in March 2002 in Blitar, East Java. It occurred after heavy rains among new fish introduced from Surabaya, the capital city of East Java. The fish were imported from PR China through Hong Kong in December 2001 and January 2002. Blitar is well known as the center for koi production in the country. The koi, including the infected animals, were distributed to the provinces of Central Java, West Java and Jakarta as the main market. The second disease outbreak occurred in cultured common carp during the end of April 2002 in Subang Regency, West Java. The gross signs shown by the diseased fish were extremely similar with that observed previously in koi carp. Subang is one of the production centers of common carp in West Java. Since then the outbreaks spread to neighbouring regencies, mainly through the movement of infected fish. The third episode of the outbreak occurred in the end of May to early June 2002 in cultured common carp in floating netcages at Cirata Reservoir, West Java. Weeks before the outbreak, farmers introduced common carp from the Subang region, due to the low price of these fish.

The fourth episode of the outbreak occurred in January 2003, affecting cultured common carp in Lubuk Lingau Regency, South Sumatera. The gross signs of the diseased common carp were extremely similar to those observed previously in koi and common carp in Java. Mass mortality of more than 90 percent was observed during the outbreak. Common carp farms at Lubuk Lingau were infected with the disease coming from Cirata Reservoir, West Java through fish transfer by traders. In January, the outbreak spread to neighbouring Provinces, including Bengkulu in the south and Jambi in the west (Sunarto, Rukyani and Itami, 2004; Yuasa *et al.*, 2004).

In this paper, two new outbreaks are reported. Although a public awareness campaign conducted by the central and local governments delayed the spread of the disease from southern Sumatera to West Sumatera, in August 2004, an outbreak that killed more than 200 tonnes of cultured common carp occurred in Singkarak Lake and Maninjau Lake, West Sumatera. The gross signs of the diseased fish were extremely similar with those observed previously in koi and carp in Java and southern Sumatera. Common carp farms on West Sumatera were infected with the disease via contaminated seed that is believed to have been transferred from Jambi Province, where KHV disease has occurred since 2003.

The sixth episode of KHV outbreak occurred in carp culture in Banjar Baru, South Kalimantan. The outbreak killed 600 tonnes of common carp in the running water culture system in September 2004. However, the mortality rate was quite low (30-50 percent) as compared with the outbreaks on Java and Sumatera islands. It is speculated that the polyculture of common carp with tilapia and high water temperate (29°C) may reduce mortality rate due to KHV. The spread of KHV into Kalimantan was thought to be due to the irresponsible movement of infected carp broodstock from Malang, East Java, where KHV is endemic.

Double cage culture system with first level using common carp and second level using tilapia

AGUS SUNARTO

EPIDEMIOLOGY

The epidemiological investigation was conducted by NACA's Task Force in July 2002. The information presented below is based on the report of Dr. Angus Cameron (Cameron, 2002).

Methodology

Investigations were conducted in the east of Java, with visits to Surabaya, Malang and Blitar. The approach used to investigate the disease was as follows:

- initial discussions with central staff in Java, and collection of existing information on the nature and distribution of the disease;
- discussions with local Kabupaten and Kotamadya officers in Blitar to collect information on the distribution of the disease in the local area;
- field visits to two farms to the northwest of Blitar and three farms to the southeast and east. At each visit, farmers were questioned about the origin, progression and behaviour of the disease;
- one visit to the Surabaya fish quarantine offices and laboratory for examination of import documents and discussion with staff relating to the importers premises; and
- in conducting the epidemiological investigations, analyzing the findings, and formulating conclusions, the team maintained contact with the laboratory investigation team to assess findings from the west of the island.

Results

The following section presents the results of epidemiological observations gathered during the investigation:

Confirmation of a disease outbreak: The 50-100 percent mortality rates reported by farmers far exceed what is considered normal and therefore a disease outbreak is confirmed.

Pattern of spread of disease: The pattern is typical of a propagating infectious disease, starting in one location and subsequently spreading both locally and over long distances. From each new disease location, further local spread has occurred. The evidence of spread of disease within farms after the introduction of fish is also consistent with the disease being caused by an infectious agent. Disease is spread downstream, with the second case-farm being located about 500 m downstream from the index farm, with a delay of about 20 days between the onset of disease in the two farms. It is still unclear what the main mechanism of water-borne between-farm spread is (whether it is through direct carriage of the virus or through either mechanical or biological vectors). It is suspected that vectors may play a role, as the relatively fragile herpes virus is unlikely to survive for long periods exposed to sunlight in the shallow streams of the region.

Nature of the pathogen: Based on available epidemiological evidence, it can be reported with extreme confidence that the disease is caused by a directly transmitted infectious agent. The rapid transmission of the disease (about seven days between introduction of infected fish and the onset of clinical signs in contact fish) and the observation that transmission has occurred in clean cement tanks with very few potential intermediate hosts present both strongly indicate that the disease is directly transmitted.

Spread of disease: Several mechanisms for spread of disease have been identified. These are:

- spread between enclosures in a farm through fish to fish contact, through water and possibly through movement of dead fish or tissues;
- local spread between farms through water and possibly non-water mechanisms such as transport of live fish or the transport of the pathogen via humans, other animals or inanimate objects (fomites) such as aquaculture equipment, and feed; and
- long distance spread – mainly through fish movements.

Incubation period: The incubation period is about seven days, and the contact rate is very high, allowing a large number of fish to become infected from a single shedding fish.

Cause of the current outbreak: There are a number of pieces of evidence that strongly suggest that the cause is viral, and is most likely to be KHV. The host specificity and pattern of mortality is the same as that described for KHV (Hedrick *et al.*, 2000) in earlier outbreaks (*analogy)*. The observation in one experiment that the disease recurred in recovered fish once they were stressed is typical of latent herpes virus behaviour, and unlikely in any of the other pathogens under consideration (*experimental)*. The failure of response to treatment with antibiotics reported in a number of cases probably provides a weak evidence that the cause may not be bacterial (*response to treatment)*. The finding of positive PCR results from affected fish (and the negative finding from unaffected fish) confirms these epidemiological assessments.

Risk factors: A number of risk factors may play a role in disease development, based on direct field observations and anecdotal evidence. These include the following:

- size of fish (large fish are sometimes reported to be more susceptible, but this may well be due to the fact that gill damage is one of the first signs of disease, and their increased requirements for oxygen);
- water oxygen levels (increasing water oxygen levels may minimize mortality in less severely affected fish);
- water flow;
- rapid collection of affected fish (to decrease the level of virus transmission);
- temperature (previous reports indicate that the virus is only active within a relatively narrow temperature range); and
- water quality, management factors, feed and treatments.

GEOGRAPHICAL DISTRIBUTION

A survey of KHV was conducted in April 2003 under FAO's Technical Cooperation Programme. The information presented below is based on the reports of Dr. Angus Cameron and Dr. Akhmad Rukyani (Cameron, 2003; Rukyani, 2003).

Objective

The main objectives of the survey were to determine the extent and the distribution of the population at risk against KHV, the current distribution of the disease and extent of the disease.

Methods

In order to achieve these objectives and meet the criteria listed above, a rapid survey at the district (kabupaten) level as a unit of interest was conducted. The survey was conducted in all of the country's 353 districts. A printed questionnaire was used to collect data. The questionnaire was pre-printed with the name of each district and province, as well as the district code, to simplify the data entry. The questionnaire was designed to be as simple and as rapid as possible to be completed, consisting of only seven questions. These related to:

- presence of at-risk species (common and koi carp);
- extent of the population at risk, measured both in terms of hectares under culture and the number of farms;
- presence of KHV disease in the district;
- date of the first report of KHV; and
- an estimate of the number of farms affected by KHV.

The questionnaire was delivered by mail to each district office. It was accompanied by an official covering letter explaining the survey and giving instructions on how to fill out the questionnaire, and an information sheet on KHV (with case definition) to enable district fisheries staff that were not familiar with the disease to determine if outbreaks in their area met the case definition.

Results

This survey is the first epidemiological survey that has been conducted in the field of fish health in Indonesia. The survey was very successful, not only in terms of the high response (90 percent of questionnaires returned), but also in terms of developing better communication and networking between the central and district levels.

Population at risk: Based on the survey results, the distribution of the population at risk (i.e. koi and common carp) is shown on the map given in Figure 1.

Progression and geographic distribution of the disease: There are arguments among scientists on when the first KHV outbreak occurred in Indonesia. This survey was designed to address this issue. The results show that the outbreak first occurred at Blitar, East Java in March 2003 and then spread to Subang, West Java (Figure 2.). The geographic distribution of KHV in Indonesia as of February 2003 is illustrated in Figure 3. The red colour indicates the districts affected by disease.

SURVEY CONCLUSIONS

This is the first epidemiological survey that has been conducted in the field of fish health in Indonesia. The communication established during the survey should lead to better communication and cooperation among institutions in the central and district level in the future. Networking with key districts should be maintained and further developed through regular communication and sharing of information on fish health matters. Finally, 90 percent (315 out of 353) of the survey questionnaires were returned. From the survey, it was found that the disease has infected most of Java, Bali, Lampung, Bengkulu and South Sumatra, as well as making incursions into Kalimantan and Sulawesi. Nationally, 31 percent of the districts culturing susceptible species (common and koi carps) reported the presence of KHV.

Patterns of local and long-distance spread were further assessed by a district (kabupaten) level national survey. The survey found that there was gradual local spread from numerous foci of infection, as well as occasional long-distance spread, initially within Java, but also to other islands. It is hypothesised that the long-distance spread is mainly associated with the transport of the high-value ornamental koi carp, while local spread is through water and local transport of common carp for human consumption.

CLINICAL ASPECTS

Infected fish were lethargic, showed loss of balance and gasped for air. Some dead fish had sloughing off the epithelium with loss of mucus and rough appearance of the skin, darkened skin or showed blister-like lesions on the skin and haemorrhages of the operculae, fins and abdomen. However, the most common clinical sign was gill damage seen as whitish coloration, white patches or severe necrosis (Figure 4).

FIGURE 1

Map showiing the distribution of common (red) and koi (blue) carp production areas in Indonesia. Pale grey areas indicate no data, dark grey indicates no production (source: Cameron, 2003; Rukyani, 2003).

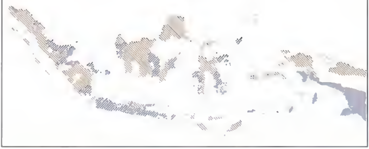


FIGURE 2

Map of the KHV outbreak during its first occurrence at Blitar (koi) and Subang (common carp) in March 2002. Pale grey areas indicate no data, green areas indicate no reported KHV, red areas have reported KHV in either common or koi carp (source: Cameron, 2003; Rukyani, 2003)

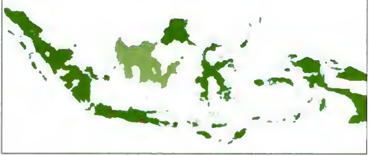


FIGURE 3

Map showing the geographic distribution of reported KHV in Indonesia as of February 2003. Pale grey areas indicate no data, green areas indicate no reported KHV, red areas have reported KHV in either common or koi carp (source: Cameron, 2003; Rukyani, 2003)

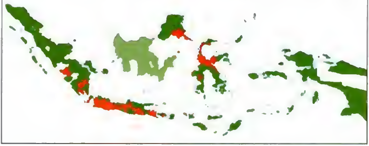
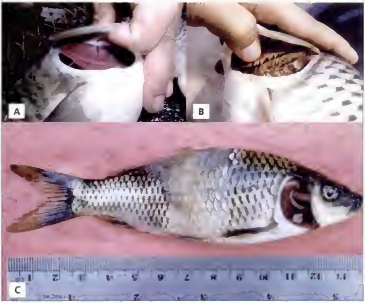


FIGURE 4

Diseased fish showing typical clinical signs – gill damage such as whitish gills (A) and severe gill necrosis (B). Some fish also showed blister-like lesions on the skin and white patches on the gills (C).



SPECIES AFFECTED

Although the disease was observed as being highly contagious and extremely virulent, morbidity and mortality were restricted to koi and common carp populations. Several other species stocked within the same ponds remained completely asymptomatic to the disease. Co-culture with a number of other species was observed in Blitar (with tilapia and gouramy) and in Cirata Reservoir (which utilizes a double cage system using carp and tilapia), and in all cases only carp were affected by the disease. However, it is not known yet whether the fish harbour the virus and act as carriers. Screening of other cultured and wild fishes such as tilapia, giant gouramy, catfish and Siam catfish, collected from the same cage, pond or canal of surrounding farms showed PCR negative results against KHV. The fish were tested with single step PCR using the primer set developed by Gray *et al.* (2002) and Gilad *et al.* (2002). However, further screening of the fish using double step PCR will confirm whether the fish is harboring the virus or not.

SOCIO-ECONOMIC IMPACT

The first report regarding the economic losses due to the outbreak was made by the head of the Association of Ornamental Fish Culture of Blitar Regency, East Java. They reported that in Blitar alone, the outbreak destroyed high quality koi carp belonging to 5 000 fish farmers with economic losses of more than Rp. 5 billion (US$0.5 million) within the first three months of the outbreak. As of July 2002, the Task Force estimated that the loss of revenue to the sector and the socio-economic impact to the rural farming communities were in the region of US$5 million. As the outbreaks continued and the disease spread to new areas, the socio-economic impact escalated. The Directorate of Fish Health and Environment (DFHE) estimated that as of December 2002 and 2003, losses due to KHV were US$ 10 million and US$15 million, respectively (Sunarto *et al.*, 2004).

PUBLIC HEALTH

There has been a great deal of local apprehension as to the consequences of consuming diseased fish. This is particularly affected by the fact that the some of the diseased fish showed blister-like lesions (Figure 4) and the word "herpes", which is associated with herpes virus in humans. There is however, no scientific evidence that the disease causes any human illness. In some outbreaks, large volumes of affected fish were sold or given away to people living in the local area for consumption, and there have so far been no reports of ill effects as a result of this. The government has conducted campaigns to eat carp. Fortunately, the Indonesian community has the habit of eating cooked fish, either fried or steamed.

AETIOLOGY

Screening for parasites, fungi and bacteria showed multiple infections on affected fish. *Dactylogyrus* sp., *Trichodina* sp., *Ichthyophthyrius multifiliis* and *Argulus* sp. were found on some debilitated fish. *Flexibacter columnaris* and *Aeromonas hydrophila* were isolated from necrotic gill filaments and skin ulcers of affected fish, respectively. *Saprolegnia* sp. and *Achyla* sp. were found in some fish showing blister-like lesions. All these species are suspected to be endemic in Indonesia and can be found in unaffected fish, so are unlikely to play a central role in the development of the disease. Attempts have been made to treat the infected fish with potassium permanganate and antibiotics (enrofloxacin, erythromycin, amoxicylin and oxytetracycline), but with no success.

At the beginning of these outbreaks, many causative factors were proposed, including water pollution, contaminated feed and bacterial infection. An infectivity trial was then conducted to elucidate the causative agent of the outbreak. Cohabitation of diseased fish with healthy common carp resulted in 100 percent mortality within an 8-day period. Experimental infections with 0.45 m-filtered homogenates resulted in 70 percent mortality during a 14-day period. Similar clinical signs (i.e. gill necrosis) were observed in both groups in the cohabitation test and injection of filtrate homogenate test.

PCR detection of KHV naturally diseased fish showed that some affected common carp produced a single band 290 base pair (bp) (Gray *et al.*, 2002) or 484 bp (Gilad *et al.*, 2003) in size, that would be expected if KHV DNA was present. However, other common carp collected from the same pond gave negative results. Partial DNA sequencing of the 484 bp amplicon revealed that the DNA sequence of KHV from Indonesia has high similarity (99.65 percent) with the DNA sequence of KHV from the United States. Nucleotide sequences of the three regions (KHV9/5 primer set amplicon, SphI-5 primer set amplicon, and thymidine kinase) of KHV DNA from Indonesia, Japan and Taiwan were identical (Ito *et al.*, 2004).

Virus isolation was attempted onto the KF-1 cell line, the cell line most appropriate for the isolation of KHV, as well as onto GP, EPC, BB, BF-2, DT and SSN-1, but did not result in any observable cytopathic effects (CPE). However, these negative results may be caused by inappropriate sample preparation. The samples were collected in various infected farms, brought to the laboratory and processed prior sending to Intervet Singapore, AAHRI (Thailand) and the University of California at Davis (United States). These extracts had arrived in the laboratories after several days of shipping and no refrigeration. Thus, it would not be surprising that no viral agents could be isolated.

However, based on the history, clinical signs, epidemiological features, histopathological changes, results of experimental infection, PCR detection of naturally and experimentally diseased fish, and analysis of DNA sequence, it is confirmed that KHV involved in this serious outbreak.

ENVIRONMENTAL FACTORS

Most of the outbreaks occurred when infected fish were introduced to non-infected fish, farms or areas. The heavy rain prior to the initial outbreak indicated the possibility of an environmental triggering factor, such as water temperature. Another environmental factor that may trigger outbreaks is stress caused by, for example, high stocking density and low water quality. However, research is needed to elucidate the environmental and other factors that trigger outbreaks.

DIAGNOSTIC METHODS

Appropriate diagnosis of KHV is important to avoid confusion with other diseases in carp. The haemorrhage and blister-like lesions seen in diseased fish may lead to a misdiagnosis as *Aeromonas hydrophila* infection. *Flexibacter columnaris* also causes gill necrosis. In fact these two bacteria were also found in the infected carp during the episode of mass mortality. Therefore, a case definition was established as an important step in the disease investigation in order to determine whether or not an individual fish, pond or tank is suffering from the disease. The case definition was used to minimize misdiagnosis. In the case of KHV, the case definition used was high mortality in koi or common carp, in which the fish shows gill damage, with or without other clinical signs.

Clinical signs and gross pathology

Infected fish were lethargic, showed loss of balance and gasped for air. Common gross signs included sloughing off the epithelium with loss of mucus and a rough appearance of the skin, haemorrhages of operculae, fins and abdomen, and severe gill damage. Some diseased fish showed a blister-like lesion on the skin, so called "penyakit melepuh" in the Indonesian language. As the outbreak continued, various clinical signs were observed or reported; however, the only consistent clinical sign was severe gill necrosis. Therefore, this pathognomonic clinical sign was used to establish a presumptive diagnosis against KHV (diagnosis level 1).

Histopathology

Although histopathological changes due to KHV were not obvious in most of the diseased fish, some diseased fish showed consistent findings with various lesions. Acute dermatitis with bacterial colonies occurred on the skin. Branchitis and numerous parasites including protozoans and metazoans, and bacterial colonies were present on the gills. Occasionally, intranuclear amphophilic inclusion bodies with peripheral chromatin margination were observed within the gill's epithelium. Similar inclusions were also observed within the kidney tubular epithelium accompanied by nephrocalcinosis. The interrenal extramedullary hematopoetic tissue showed haemorrhage or haemosiderosis. Epicarditis, myocarditis and endocarditis were demonstrated in the heart. Multifoci of chronic pancreatitis with acinar cell necrosis were present in the pancreas. The liver displayed various types of degeneration such as hydrophic degeneration and fatty change. Occasionally, vasculitis and bile stases were observed within the sinusoid of the liver. The spleen was congested and displayed the occurrence of perivascular amyloidosis (diagnosis level 2).

PCR detection

PCR detection of KHV was carried out using specific primers set developed by Gray *et al.* (2002) and Gilad *et al.* (2002). Nine laboratories in Sumatera, Java and Sulawesi have routinely used PCR assay for confirmative diagnosis against KHV (diagnosis level 3). However, mixed results were occasionally found by using this molecular-based method. As the detection of fish pathogens in Indonesia using PCR assay is still in its early development, standardized methods and harmonization of PCR application is urgently needed to ensure high quality results.

CONTROL MEASURES

The recent increase in live-fish traffic is increasing the risk of introduction and spread of fish pathogens throughout the country. Past and recent disease outbreaks among cultured and wild fish have prompted the government to carry out a programme to control disease and protect fishery resources.

Attempts to control the outbreak at the farm level have also been made. These efforts include curative approach (treatment by using of antibiotics, disinfectants and other pharmaceuticals) and a preventive approach (by quarantine measures, biosecurity, vaccination and good management practices (GMPs)).

Treatment

No drugs or other pharmaceuticals have been found to be effective in combating the disease. Attempts have been made to treat the infected fish with antibiotics, but without success. Some fish farmers have tried to use potassium permanganate (PK) for treatment. However, PK tends to irritate the gills, leading to a surging mortality up to 80-95 percent of affected fish. Since other pathogens such as parasites, fungi and bacteria were also found in the diseased fish, antibiotics and disinfectants were used to treat these secondary infections. Enrofloxacine (5-10 ppm) was used to treat secondary bacterial infection. Dyvon (dichlorphos) at 1-5 ppm and benzalkonium chloride (BKC) at one drop/100 L were used to treat *Argulus* and other parasitic infections.

Quarantine

Since most outbreaks occur after the introduction of new infected fish, it is obvious that the disease is spread by direct contact. Therefore, the effective way to protect a non-infected area from being infected with the disease is by preventing the introduction of infected fish. It is recommended that all new fish be quarantined for at least two weeks, together with sentinel fish at a permissive water temperature between 18-28 °C.

Biosecurity

Most outbreaks occurred after the introduction of new fish from an infected area or through infection via contaminated equipment or water source. Therefore, the biosecurity concept may be applied to prevent or reduce the possibility of KHV infection. For areas where KHV is presently endemic, a prevention programme should include eradication and exclusion activities. Given that KHV also occurs in wild carp stocks, it can be difficult to control outbreaks in common waterbodies such as in floating netcages in lakes and in raceways in rivers. Although little is known about how the virus survives between the outbreaks, available evidence suggested that infections may persist in the susceptible fish population remaining at the site between crops. Accordingly, measures to eradicate the virus should include: removal of all fish (particularly all susceptible fish species) from ponds, reservoirs, and water canals prior to restocking, drying out and liming the ponds and disinfecting of contaminated equipment. Potassium permanganate (10 ppm), chlorine (200 ppm) and formalin (500–1 000 ppm) were commonly used as disinfectants. Once the virus has been eradicated from a site, it is important to prevent re-introduction. It is likely that infection is spread by affected fish, as well as by contaminated water and equipment. Ronen *et al.* (2003) reported that KHV remains active in the water for at least four hours. Accordingly, the following measures should be considered for the exclusion of the virus from fish farms: seed and broodstock should be KHV-free or be obtained from KHV-free areas, all wild carps must be rigorously excluded from farms in endemic areas, use only KHV-free water, either decontaminated or originating from KHV-free water sources, and equipment which may have been used at infected sites must be disinfected. These practices have been adopted and proved to be effective to prevent the outbreak in an isolated koi farm. However, they may not applicable for culture systems in open waters such as cage culture in lakes and raceway culture in rivers. In these systems, GMPs may be applied to reduce mass mortality due to KHV infection.

Good management practices

KHV now appears to be endemic in most areas of Indonesia where carp and koi are cultured including Java, Bali, Sumatera and Kalimantan. Emphasis should now be placed on learning how to manage the disease so that carp production in infected areas can be maintained (Arthur, 2003). There are scattered reports from fish farmers that GMPs can reduce the incidence of and mortality due to KHV infection in koi and carp culture. However, these reports need to be backed up with scientific data. The koi farmer association of Blitar Regency reported that although KHV is still found in their koi, the mortality due to KHV is very low. There is an area in Cirata Reservoir that managed to get free from the outbreak, even though sharing the same waterbody with other infected areas. Blitar and Cirata are the centers of production of koi and common carp, respectively. These two areas were badly affected by the outbreak in 2002. There are reports that transferring diseased fish from raceways to earthen ponds will decrease mortality and prevent further losses. It seems that this practice reduces the stocking density and provides stable water temperature, hence providing a better environment for the fish. Other farmers have reported that polyculture of common carp with other fish species such as tilapia and gouramy, also reduces the severity and frequency of KHV outbreak.

It is important that the general health, as well as the KHV status, of a susceptible fish population is monitored regularly during the grow-out period. High doses of vitamin C (500 mg/kg feed) were used to enhance fish immunity against infection. It is hypothesized that the disease outbreaks do not occur if the fish's defence mechanisms manage to contain low-intensity of KHV infection under low-stress culture conditions. Conversely, outbreaks may occur under stressful conditions. Therefore, avoiding stress factors such as high stocking density, fluctuating water temperature, low dissolved oxygen and improper handling of fish are essential to reduce the risk of outbreak. It is recommended to remove dead and moribund fish from the pond, as they are a good reservoir for the virus. Record keeping, epidemiological analysis and accurate diagnostic tools are essential for pond monitoring. To break the life cycle of KHV and to avoid re-occurrence of outbreaks in endemic areas, it is recommended to farm species that are resistant to KHV, such as tilapia, gouramy and catfish.

Vaccination

Attempts have been made to control outbreaks by using antibiotics and other drugs, but this has had no success. As KHV is an immunogenic virus, preventive measures a using vaccination programme would be effective to control the disease (Ronen *et al.*, 2003). A preliminary "vaccination trial" by temperature manipulation has been conducted in the Fish Health Research Laboratory (Gardenia *et al.*, 2004). The trial methods involved the cohabitation of healthy fish with sick fish at permissive temperature (26-28 °C) and their subsequent transfer to non-permissive temperature (32-35 °C). At thirty days post-exposure, the vaccinated fish were then challenged by cohabitation with sick fish. The results show that the vaccinated group has lower mortality (33 percent) compared with the control group (86 percent). Although beneficial to reduce the mortality of fish, this vaccination method involves a serious risk due to the use of live virus. Research on the development of inactivated vaccine is being conducted.

CONCLUSIONS

The NACA's Task Force findings revealed that an infectious agent is involved in the current outbreak. Epidemiological evidence and positive PCR findings from 82.5 percent (33/40) of the case samples indicated that the outbreak was most probably caused by KHV, despite the failure to isolate the virus, to observe the virus with electron microscopy and to find typical histopathological changes described in other cases of KHV. The disease was introduced into Indonesia through fish importation and spread to other areas within the country through fish movements. Since most of the episodes of mass mortality in koi and common carp occurred within a few weeks after the introduction of infected fish into disease-free areas, the responsible movement of live fish and quarantine of incoming fish seem to be a logical way to prevent the introduction and spread of the disease to new areas.

Although KHV is strongly suspected to be the cause of the outbreak, this has yet to be confirmed. Further research on the identification and confirmation of the disease is urgently needed. Other areas of research that need to be pursued include the development of standardized procedures for the detection of the virus, with emphasis on the detection of subclinical fish and potential carriers, if any. Research is also needed to identify environmental and predisposing factors and to analyze risk factors that trigger the outbreaks. Control strategy through the development of vaccines is another area of research that should be considered.

Despite the difficulties in the control of outbreaks in common waterbodies such as raceway culture in rivers and netcages in reservoirs and lakes, a vaccination programme, biosecurity measures and GMPs seem to provide alternative control strategies at the farm level. However, further research is needed to analyse the cost effectiveness of a vaccination programme in common carp and to identify the key components of biosecurity and GMPs that are effective to control KHV outbreaks. Although, the government has attempted to restrict the spread of the disease to new areas by issuing rules, regulations and technical guidelines, the disease is still spreading to new areas. Better law enforcement and improved public awareness are essential to ensure the proper implementation of the regulations and guidelines.

The Government of Indonesia still faces significant challenges in the implementation of emergency response to disease outbreak. Capacity building on emergency preparedness and response is needed to properly manage disease emergencies. The general approach would be the proper development and implementation of the National Strategy for Fish Health Management.

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Responses to Koi Herpes Virus (KHV) outbreaks in Japan

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ABSTRACT

The mass mortality among common carp (*Cyprinus carpio*) caused by Koi herpes virus (KHV) infection occurred in early October 2003 in Japan. KHV infection has been diagnosed in accordance with a guideline for the disease, and confirmation is based on the results of the polymerase cahin reaction (PCR) examinations. The local authorities have officially declared that the movement of KHV-affected common carp and koi is prohibited and have ordered the destruction of KHV-affected common carp and koi under the Law to Ensure Sustainable Aquaculture Production.

INTRODUCTION

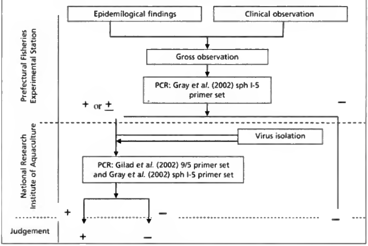
Koi herpes virus (KHV) is highly contagious and virulent in common carp and koi (*Cyprinus carpio*). KHV infection first occurred in 2003 in Japan, and has caused heavy damage to common carp culture. In this report, we present responses to the KHV outbreak and the current status of the disease in Japan.

DIAGNOSTIC SYSTEM FOR EXOTIC DISEASES AND KOI HERPES VIRUS DISEASE

In Japan, some exotic diseases are designated as "Specific Diseases" in the Law to Ensure Sustainable Aquaculture Production (Law No. 51, 1999). This designation is used for exotic diseases such as spring viraemia of carp (SVC) and viral haemorrhagic septicemia (VHS) of salmonid fish that have the potential to devastate the aquaculture industry in Japan. For such diseases, protective guidelines are established. The guidelines provide etiological information, diagnostic procedures, and description of the clinical signs and other important characteristics of the disease. Laboratory diagnoses of the diseases should be conducted in accordance with these guidelines.

A newly isolated herpes virus, Koi herpes virus (KHV), was first reported as a pathogen causing of mass mortality of common and ornamental (koi) carp cultured in Israel and the United States in 1998 (Hedrick *et al.*, 2000). In Japan, no such mass mortality of cultured carp had been reported, and KHV had not been detected by a survey conducted in Niigata Prefecture (Amita *et al.*, 2002). It has been shown that

FIGURE 1
Inspection chart for KHV infection according to the Japanese guidelines


Prefectural Fisheries Experimental Station
Epidemilogical findings
Clinical observation
Gross observation
PCR: Gray *et al.* (2002) sph I-5 primer set
+ or ±
–
National Research Institute of Aquaculture
Virus isolation
PCR: Gilad *et al.* (2002) 9/5 primer set and Gray *et al.* (2002) sph I-5 primer set
+
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KHV is highly contagious and virulent in juvenile and adult carp (Hedrick *et al.*, 2000, Perelberg *et al.*, 2003). Therefore, on 30 June 2003 KHV infection was added to "Specific Diseases" in the Law, and an inspection chart was established in the guidelines (Fig. 1).

According to the chart, the Prefectural Fisheries Experimental Stations first conduct epizootic and routine clinical examination on diseased fish. The most important epizootilogical aspects of KHV disease are that it only affects common and koi carp (*C. carpio*) and it occurs, remarkably, at temperatures from 18 to 28 °C (Hedrick *et al.*, 2000; Gilad *et al.*, 2003). Therefore, the water temperature and affected species of fish should be determined during a field examination. Few external signs are usually visible, but pale and necrotic gills are frequently evident. Infections by *Flavobacterium columnare* (=*Flexibacter columnaris*) and some protozoan parasites such as *Chilodonella* and *Trichodina* are sometimes found on necrotic gill lesions, easily leading to misdiagnoses.

If any doubt remains as to the presence of KHV infection, a polymerase chain reaction (PCR) test can be used to detect KHV DNA in the tissues of fish, usually gills. The PCR method described by Gray *et al.* (2002) was adopted in the inspection chart as the primary examination to be conducted by the Prefectural Fisheries Experimental Stations. When there is some evidence of a positive reaction in the PCR test for KHV, the sample is sent to the National Research Institute of Aquaculture (NRIA) for further examination by the PCR methods of both Gilad *et al.* (2002) and Gray *et al.* (2002) for confirmation. Viral isolation is also attempted using KF-1 cell line (Hedrick *et al.*, 2000). Because of the difficulty of isolating the virus in the cell line, the results of the isolation trial are considered supplementary data. Confirmation is based on the results of the PCR examinations.

OCCURRENCE OF KHV INFECTION IN JAPAN AND PRACTICAL DIAGNOSIS OF THE DISEASE

The mass mortality among common carp cultured in net-pens at Lake Kasumigaura, Ibaraki Prefecture, central Japan, began in early October 2003 (Fig. 2). At the time, the water temperature of the lake was 16-18 °C. The fish swam lethargically near the water

FIGURE 2
Mass mortality of common carp caused by KHV at Lake Kasumigaura

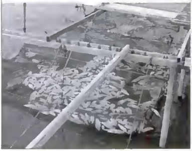
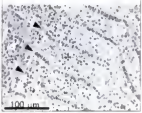


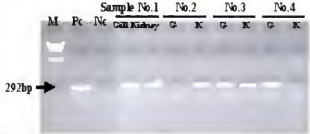
FIGURE 3
A tissue section of the gill from affected common carp cultured at Lake Kasumigaura. Arrowheads indicate secondary lamellae. H&E stain



surface. No marked external signs were observed in the most affected fish, but a whitish mucous-like substance on the body surface, redness of the fins and body, fin rot, and discoloration of the gills with some necrosis were sometimes noticed. The mortality was over 60 percent in the most severe cases, especially in larger carp (those in older than 2-years-old). The losses of the cultured carp were estimated to be 660 metric tonnes in early November and reached approximately 1 200 tonnes by mid-November, which is approximately one quarter of the annual production of the lake.

External parasites, such as *Chilodonella*, *Trichodina* and *Gyrodactylus*, were sometimes seen on the necrotic gill tissues of the affected fish. Marked histopathological changes were observed in the gill of the diseased carp (Fig. 3). The secondary lamellae were often fused with hyperplastic branchial epithelium where cell necrosis or the infiltration of lymphocytes was often observed. Congestion and hemorrhage were sometimes observed. In some cases, the branchial tissues were severely degraded and numerous bacteria were seen in the lesions. These histopathological changes are similar to those seen in the previous reports of KHV infection (Hedrick *et al.*, 2000; Tu *et al.*, 2004). Unlike with the previous report of Hedrick *et al.* (2000), nuclear changes characterized by hypertrophy and margination of chromatin were rarely observed. No bacteria dominantly isolated from the kidney of affected fish were observed on trypticase soy agar (TSA). The PCR for KHV amplified specific bands by the methods of Gray *et al.* (2002) and Gilad *et al.* (2002) (Fig. 4). Direct sequence of the amplicon by the primer set of Gray *et al.* (2002) corresponded completely with the GenBank accession no. AY568951, and that by the primer set of Gilad *et al.* (2002) showed 99 percent matching to AF411803.

FIGURE 4
Gel electrophoresis of the products (292bp) amplified with the primer set sph I-5 of Gray et al. (2002) from the extracted sample of gill and kidney of affected fish cultured in Lake Kasumigaura. Pc: positive control, Nc: negative control. 1 percent agarose gel stained with ethidium bromide



Properly, on 2 November 2003, the Ministry of Agriculture, Forestry and Fisheries of Japan officially announced the first occurrence of the disease in Japan. It was also reported to the Office International des Épizooties (OIE). According to the Law, the Governor of Ibaraki Prefecture officially prohibited the movement of cultured carp from the lake, and ultimately ordered that all carp cultured in the lake were to be destroyed by the end of March 2004.

OTHER EVIDENCE OF KHV BEFORE THE OUTBREAK AT LAKE KASUMIGAURA

Independently of the KHV outbreak at Lake Kasumigaura, a massive loss in excess of 10 000 carp occurred in the rivers and a lake in Okayama Prefecture, western part of Japan, in late May to mid-July 2003. In November 2003, the NRIA detected KHV DNA by PCR in the samples of the diseased fish stored in a freezer. This demonstrates that KHV had been introduced into Japan by May before the Lake Kasumigaura outbreak.

THE SPREAD OF KHV IN JAPAN

The KHV-infected common carp cultured in Lake Kasumigaura had been transferred to other areas in Japan before the first detection of the KHV DNA by PCR, and therefore, the virus had spread as a result. In warm-water facilities such as those used for indoor game fishing, some mortality of carp was recorded. However, in many cases KHV was detected in carp with no mortality; this was attributed to the fact that the water temperature was gradually decreasing at the time. By the end of 2003, the NRIA has accepted 529 individuals of 87 cases to be diagnosed, and KHV-infected carp were found in 23 out of 47 prefectures in Japan.

No occurrence of the disease was reported during the winter period. However, as the water temperature increased in the spring of 2004, KHV reappeared in the area where the disease had been recorded and also in new places. In many of the facilities that experienced outbreaks of KHV infection during the previous season, the disease has not been observed so far this year. In these places, all the carp, as well as other fish species, were removed and the facilities were properly treated with disinfectants after the outbreaks. By the end of July 2004, KHV infections have been reported in 39 prefectures in Japan.

OFFICIAL CONTROL MEASURES IN JAPAN

The Government of Japan has conducted surveillance throughout the country and has controlled the movement of common and koi carp through local governments in accordance with the advice issued by the Technical Commission for KHV Disease. The commission is comprised of experts in fish pathology and representatives from the Prefectural Fisheries Experimental Stations.

Each local government has inspected common and koi carp within its territory for signs of infection and has checked for the presence or absence of KHV infection using a PCR test. The local authorities of the KHV-affected area have officially declared that the movement of common carp and koi carp from the area where KHV has been confirmed to other areas is prohibited and have ordered the destruction of common and koi carp in the area under the Law.

RESEARCH ACTIVITIES ON KHV AT NRIA

The NRIA and other research groups, including universities and the Southeast Asian Fisheries Development Center (SEAFDEC) have begun a research project on KHV infection funded by the Ministry of Agriculture, Forestry and Fisheries of Japan. This project, which will have a duration of three years, consists of three major activities: 1) molecular virology and histopathology of KHV infection, including viral behavior in infected fish at different temperatures and a carrier state; 2) development and evaluation of diagnostic tools such as a loop-mediated isothermal amplification (LAMP) method and immunocytochemistry; and 3) measures to control infection, including the efficacy of disinfectants, vaccination and elevation of the rearing water temperature. The results could contribute for controlling KHV infections in both wild and cultured populations of carp.

ACKNOWLEDGEMENTS

We are grateful to Prof. Ronald P. Hedrick of the University of California, Davis, the United States, for his invaluable suggestions and for providing the KF-1 cell line and a KHV isolate. We thank the Ibaraki Prefectural Experimental Station and Okayama Prefectural Experimental Station for providing the sample fish, and the staff of the Aquatic Animal Health Division, National Research Institute of Aquaculture for running diagnoses of KHV infection.

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Preparedness and response to aquatic disease emergencies: the relevance and role of the private sector

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ABSTRACT

The private sector is often the most seriously impacted in disease emergencies and yet, paradoxically, is frequently overlooked in the planning and development of contingency plans and responses to aquatic disease emergencies. While it is true that some disease problems can be self-inflicted, this is most often due to lack of an adequate knowledge or appreciation of the disease risks associated with a particular activity. This is exacerbated by the multi-functional structure of the private sector, where different stakeholders may have drastically different motivations and attitudes to risk. Preparation of contingency plans and disease responses without adequate consideration and communication with the different private-sector stakeholders will usually result in severe problems in their implementation. This paper looks at the structure and role of the various private-sector stakeholders in the aquaculture industry and uses two shrimp disease case studies – yellowhead and white spot diseases in Thailand and "loose shell syndrome" in India – to illustrate how the public and private sectors can effectively collaborate in a structured approach to aquatic animal disease emergencies.

INTRODUCTION

Most aquaculture activities in Asia, and around the world, are conducted by the private (i.e. non-governmental) sector. These range in size and complexity from the growth of trapped fish in small ponds for household or local consumption to large conglomerates breeding and growing expensive seafood items for export, and everything in between. Governments, in general, tend to play a facilitating role (through technology transfer and extension), a regulatory role or some combination of the two. There is also a tendency of governments in Asia to adopt a largely "laissez faire" attitude, either due to the importance of private-sector aquaculture in local and national economies (including as a source of food security), or as a result of a lack of sufficient resources to manage private-sector aquaculture activities. Only recently have some governments begun to regulate more closely private-sector aquaculture, often as a result of external pressures such as disease, market pressure and/or food safety concerns. In general, however, private-sector aquaculture is generally left to develop on its own, except where obvious resource conflicts lead to the need for regulatory agencies to take action. By the same token, it is the same private sector that suffers in the event of aquatic disease emergencies through loss of stock, food, income and livelihood.

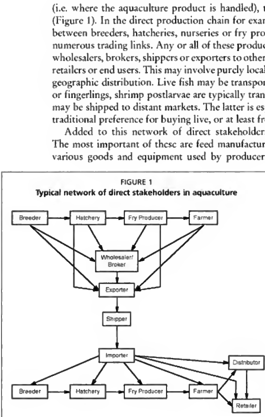
Although there are some examples of large conglomerates involved in aquaculture, usually for high-value species, this is far from common. Asian aquaculture is largely "small-scale", even in high-value species such as shrimp, individual farmers owning a few small ponds or cages. Thus, the typical scenario in most countries is of large numbers of small farms, each owned and operated independently. This type of development also leads to constraints in effective government regulation, since the resources and logistics required to contend with large numbers of small farms, many of which may be geographically remote, are often beyond the capacity of state agencies.

THE STAKEHOLDERS

However, the farming sector represents only one group in the complex web of interconnected activities that comprise the private sector in aquaculture. If we consider the various stakeholders that have a direct stake in aquaculture production (i.e. where the aquaculture product is handled), the picture becomes more complex (Figure 1). In the direct production chain for example, we may have a differentiation between breeders, hatcheries, nurseries or fry producers and farmers. Then there are numerous trading links. Any or all of these producers may sell their products through wholesalers, brokers, shippers or exporters to other producers, distributors, processors, retailers or end users. This may involve purely local movements, or there may be a large geographic distribution. Live fish may be transported between different islands as fry or fingerlings, shrimp postlarvae are typically transported large distances and live fish may be shipped to distant markets. The latter is especially important in Asia given the traditional preference for buying live, or at least fresh, seafood.

Added to this network of direct stakeholders, are a few indirect stakeholders. The most important of these are feed manufacturers, feed suppliers and suppliers of various goods and equipment used by producers. In some countries, there is also a network of private advisors or consultants and laboratories offering services and advice to producers. Although not involved in the day-to-day running of aquaculture operations, such advisory service providers can play an important and influential role in the producers' decision-making.

FIGURE 1
Typical network of direct stakeholders in aquaculture



With such a complex network of stakeholders, it is interesting to consider what factors drive the decision-making process. Obviously, with such a large number of players and a diverse range of interests, there is seldom any hierarchical management structure that will influence the entire process. Rather, the development of private-sector aquaculture (i.e. what the private sector "does") is the net result of decisions made in the self-interest of all of the stakeholders involved – both direct (farmers and producers) and indirect (suppliers and consultants). In each of these groups, self-interest may result in some contradictions. Feed companies want to sell more feed, and thus there is a pressure to intensify production and increase the dependence on formulated feeds. Farmers want to increase profit and reduce costs, one of the largest of which is feed. Greater intensity of production has the potential to result in more disease outbreaks but also the potential for higher profits and so on.

Much of the decision-making at farm level is based on the familiar risk:reward scenario and is largely driven by economic considerations. Even in small-scale, so-called "subsistence" farms, decisions are often made on what will provide the highest return. Higher intensity farming may carry greater risk, but the potential reward is also attractive. This can be seen particularly in the case of the rice vs shrimp farming debate. Many rice farmers who switched to shrimp saw it as a worthwhile risk given the poverty associated with rice farming and the comparatively high return from a single successful crop of shrimp. This enabled many poor rice-farming families in coastal areas to escape the poverty trap but unfortunately, outbreaks of yellowhead virus (YHV) and white spot syndrome virus (WSSV) meant that others lost more than they could afford due to the higher costs of shrimp production. Only when the perceived risk of losses due to disease was higher than the potential reward did attitudes change.

Attitude to risk, however, is also an important aspect of decision-making within private-sector aquaculture, especially with respect to disease. The acceptance of risk varies between individuals and also with the distance from the direct impact (particularly economic impact) of a given risk on an individual business. Different individuals vary in their aversion to risk, and it is clear that some farmers accept a higher level of risk than others. For example, some farmers are willing to pay extra for shrimp postlarvae that test negative for serious viral diseases such as WSSV, whereas others prefer to pay less for postlarvae that have not been tested, despite the experience of many farmers and the results of epidemiological investigations that show the probability of disease outbreaks is much lower with negative-tested postlarvae. In the case of catastrophic, easily transmitted, epidemic diseases, individuals may accept a level of risk that exposes not just themselves, but all of their neighbours, to a high risk of disease outbreak. Disease is often considered as an "external" risk factor outside the control of the producer until such time as it becomes widespread and endemic, by which time it is often too late to impose any form of control.

Similarly, the impact of disease on a single farm may be devastating for that farmer but has less effect on, for example, a hatchery or feed supplier, since their business is not dependent on a single farm and they are less exposed to the disease risk until it becomes widespread. For example, poor hatchery biosecurity and hygiene may result in problems that manifest themselves long after the animals have been stocked in ponds, resulting in losses to the farmer that may or may not be clearly attributable to the hatchery practices.

The private sector is generally concerned with its local situation and direct threats to livelihood such as disease, market demands and even government regulation (e.g. in the case of bans, moratoria and restrictions on business activities). By comparison, the public or government sector has to take account of the total picture and balance the needs of all stakeholders on a national, and sometimes international, basis. The key is how to take both of these concerns into account and balance the reduction of disease risk through means that do not excessively affect livelihoods in the private sector.

The private sector response to a disease threat or outbreak depends on several factors, and not all of the stakeholders have the same resources or access to resources that may be required. If the impact on business, real or perceived, is great, there will be a greater likelihood that the private sector will act quickly and comprehensively, especially if there is a short-term impact. This is not to say that such efforts will be concerted or well coordinated. An emergency on a single farm may result in a greater level of precaution on nearby farms but will not translate into concerted action to respond to the emergency until a disease affects a greater number of farms or appears to be spreading. This may not engender a response by suppliers until enough farms are affected that their business suffers. Similarly, processors and exporters may not be motivated until they are unable to source sufficient raw materials for their needs and so on. Only rarely, and under specific, usually epidemic, situations will the entire industry work together to resolve the problem. This is not so different from government agencies that may be unaware of the importance of a developing disease situation until a sufficiently large number of farms are affected.

Farmers

At the farm level, farmers may have access to their own, usually limited, financial resources as well as their staff and on-farm equipment. Although this would generally be used to deal with problems at their own farm, in the case of a serious epidemic, they may be pooled among a number of farms. The level of effectiveness will depend upon the level of training and education of the farmers and their staff, as well as their level of preparedness. Few farms have a contingency plan in place for catastrophic disease and thus depend on the experience of the staff on site. Training and assistance in developing on-farm contingency plans, ability to identify problems early and a well-defined system of communication can all be used to improve the level of preparedness and response to disease emergencies. This is especially true when there are well-organized farmers' groups or associations that can assist in organizing training and disseminating information. The farmers' motivation to assist in such planning is clearly linked to their suppliers.

Suppliers

Farm suppliers have the advantage of a network of sales and technical advisory staff who can support extension activities to the farms. Although often viewed as being in competition with government services or as being unreliable technically, they are generally able to provide a more frequent and better level of service and support, since their funding is derived from profits, and can usefully complement government services in some cases. For example, feed company support was elicited in the cases of WSSV and YHV outbreaks in Thailand to disseminate information (brochures, newsletters, posters etc.) prepared by the Thai Department of Fisheries to the farm level, as well as providing some additional funds for printing etc. This was justified as a way of supporting their customers to prevent disease transmission and thus protecting their market.

The major issue with private-sector technical support is the quality of services provided, especially in the event of a disease outbreak. Under such situations, opportunistic suppliers can exacerbate the problem by providing ineffective "cures". This causes confusion and can actually delay or reduce the effectiveness of prevention and eradication programmes. Nor are such situations necessarily simply the result of unscrupulous individuals taking advantage of farmers. During an epidemic, farmers desperately search for solutions, and when they find an apparent solution, they will spread the information by word-of-mouth. Such opinions are seldom, if ever, supported by other than anecdotal evidence but often find widespread adoption. If this involves a particular product, salespeople of the product will actively promote the solution to others, especially when many farmers insist that they have seen results. Indeed, sometimes the weight of popular belief is such that government technical support services also spread the information in an attempt to assist as many farmers as possible. This is not due to a conscious attempt to take advantage of farmers but a sincere desire to help and a belief that, in the absence of scientific evidence to evaluate the claims, popular opinion carries considerable weight as evidence of efficacy.

Ensuring quality of technical support services is complex and requires considerable effort and communication between the support providers. Preparedness plans need to recognize and take account of the varied roles played by different stakeholders, their ability and willingness to assist and ensure regular communication and update between them and the relevant authorities.

In many cases, suppliers can also provide a significant source of assistance and access to finances, usually through marketing and technical support funding. Many feed companies and other suppliers provide newsletters and seminars to farmers, for example. Although primarily aimed at product support, they frequently invite third parties to contribute in key areas of expertise and interest to their customers. Prevention and control of aquatic animal diseases are usually of interest to farmers, and company-sponsored communications can be used to provide information to farmers on what to do and who to contact in the event of an emergency. Some suppliers also provide laboratory services and analyses to customers. These can be integrated so that they complement, rather than compete with, existing government services.

Buyers

Buyers may be the last group to be significantly affected by outbreaks of disease, especially if these are confined to a limited area, since they may be able to compensate for local shortfalls by sourcing raw materials from other areas. However, as businesses they are often aware of the potential impact of catastrophic disease on their profitability and ability to fulfil forward contracts and can be a significant source of support for preventative activities.

Apart from financial support, they can play an effective role in planning, since they usually have good connections directly to farms, especially with respect to harvesting. Information on harvest yields, emergency harvests and presence of unusual clinical signs in harvested animals can be gathered. They can also be an invaluable source of information on trading networks, both formal and informal. These networks need to be taken into account in preparation of contingency and preparedness plans for disease outbreaks, since they may play an important role in transmission of disease.

Multinationals

Some aquaculture industries, especially the high value ones, may involve companies that have a multinational presence. Their business may be related to feed or other supplies, or to other areas, such as animal health. Such groups may have access to international expertise, either in-house or in their network of contacts and in some cases, may be willing to use these to deal with disease outbreaks. Some companies also have access to sophisticated laboratory facilities that can complement those available to local or regional organizations. A good example of this is the assistance provided by the Intervet company in dealing with the outbreak of disease in koi carp in Indonesia in 2003.

Others

Some countries (e.g. India) have extensive private consulting networks supporting farmers. These operate as quasi-independent extension services and usually service clients in a limited local area. Many of the comments related to suppliers are also relevant here, especially when a significant portion of their income is derived from product sales or distribution.

Stakeholder motivation

Clearly, the different stakeholders need to have some motivation. This will vary depending on their involvement and role in the industry (Table 1).

TABLE 1.
Possible roles and motivations for different private-sector stakeholders.

Stakeholder	Role	Motivation
Farmers/farmer groups	Development of contingency plans (farm and local), implementation	Livelihood
Suppliers	Reporting, advisory, dissemination of information, laboratory services	Customer support, market reputation, competitiveness
Buyers	Reporting, provision of incentives(?)	Maintain supply, cost-competitiveness
Multinationals	Technical support, information dissemination, development assistance	Investment, market development, political influence

CASE STUDIES

The following two case studies can serve to demonstrate how the private sector can play an effective role in the development of a response to disease outbreaks – WSD and YHD of shrimp in Thailand and "loose shell syndrome (LSS)" of shrimp in India. Both of these case studies involve shrimp, mainly due to the author's experience but also due to the fact that the shrimp private sector is among the best developed in Asian aquaculture.

Case study 1: Yellowhead Disease (YHD) and White Spot Disease (WSD) in Thailand

The Thai response to the initial outbreak of WSD in shrimp benefited considerably from the experience of the industry and government agencies involved with the outbreak of YHD that had occurred a year earlier. In the YHD outbreak, a multidisciplinary task force was established which comprised members from the public and private sectors. Two government agencies were involved - The Royal Thai Department of Fisheries (DOF) and the National Center for Genetic Engineering and Biotechnology (BIOTEC), as well as researchers from several key universities such as Chulalongkorn University, Kasetsart University, Mahidol University and Prince of Songkhla University, and key groups in the aquaculture industry, mainly farmers' associations and some feed companies, such as Aquastar and Charoen Pokphand.

Following initial meetings to discuss what was known about the disease, a committee was established to determine what information was required, what steps should be taken and, more importantly, what funding was available. Based on this, several short-term research projects were established to answer specific questions aimed at managing the outbreak, such as how the disease was transmitted and, once it was established that a virus was involved, whether it could be transmitted through the feed, a major concern of farmers and feed companies alike. These projects were funded through a combination of public and private-sector funds, since government budgets did not include contingency funds for emergencies and private-sector collaboration in research was a key component of most of these projects. At the same time, it was clear that information had to be widely disseminated to farmers to allow them to identify the problem and what steps to take. The DOF oversaw the preparation of a series of brochures and posters that were partly funded by the private sector and were widely distributed through the DOF's fisheries stations and by feed companies and other farm suppliers.

These steps did not completely halt the outbreak of YHD, but it was widely agreed that they served to limit the extent of the damage, allowing the industry to recover more rapidly than would otherwise have been the case. It also provided a good model of public and private-sector collaboration to deal with a disease emergency.

In the case of WSD outbreaks (and as is the case in most disease outbreaks), the initial reports of disease came from farmers. News of unusually high mortalities was spread by word of mouth between farmers and through feed salespeople, suppliers and government agencies. The most obvious clinical signs, white spots on the carapace, led to the naming of the problem "white spot disease" and allowed easy diagnosis of affected ponds.

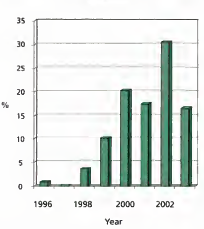
Initially, management and treatment efforts were based on earlier experience with YHD. Farmers' efforts were supported with advice by the DOF and the technical support teams of various suppliers. When these were unsuccessful, some of the major private-sector organizations (large farms and feed companies) requested the government agencies to reactivate the Yellowhead Task Force to plan a nationwide response. Information and experience with the problem were freely shared in order to establish an appropriate picture of the progress of the disease. Through careful examination of the available data submitted by the private sector, it was clear that mortalities were associated with postlarvae, even though at this point no pathogen had been identified. This resulted in a focus on broodstock, hatcheries and postlarvae as a principal route of transmission.

Many samples of infected shrimp were sent for histopathology, much of it paid for by the private sector. Eventually, a virus was found and transmission studies showed that it was indeed responsible for the disease. Under the guidance of the task force, the next priority was to develop a rapid diagnostic test to detect subclinical infection with a view to screening postlarvae. Researchers at Mahidol University had experience with polymerase chain reaction (PCR) technology as a diagnostic tool and quickly developed primers that could be used as a rapid test for screening. The primers were shared with other laboratories, and testing was widely implemented both for screening broodstock and postlarvae, and for searching for potential carriers or reservoir hosts.

Once again, the private sector collaborated in the preparation, funding and dissemination of information on the disease and possible control measures to mitigate the situation. In some cases, affected farmers were given additional credit by suppliers, allowing them to restock and get back into production quickly. Unfortunately, subsequent disease outbreaks and stock losses often meant that farmers were unable to meet their obligations, causing major debt problems. This, together with problems in managing debt and revenue collection, resulted in the collapse of the Aquastar contract farming system in the south of the country.

As in the YHD outbreak, it is difficult to assess how effective these efforts were in reducing losses due to the disease. However, the relatively rapid recovery of the Thai shrimp industry following the WSD outbreaks compared to that of other countries does give some idea of the effectiveness of the public/private-sector collaboration in dealing with disease emergencies. In addition, the legacy of this experience can be seen in the involvement of the industry itself in preparing its own preparedness plans. Privately operated PCR laboratories, some owned by the farmers' associations themselves, now screen broodstock and postlarvae for a range of viruses, and farmers' organizations provide regular updates to members on the disease situation in the country. Some are even developing their own preparedness plans for new diseases (e.g. Taura syndrome) before they become significant problems. Feed companies and other suppliers organize

FIGURE 2.
Estimated prevalence of LSS in India in 1996–2003 (courtesy Indian Society of Aquaculture Professionals)



regular seminars/workshops to update on important issues facing the industry, including disease threats, and the private sector is collaborating with the DOF in the development and implementation of Codes of Conduct and Good Management Practices for quality shrimp.

Loose shell syndrome of P. monodon *in India*

DANIEL FEGAN

Case study 2: Loose Shell Syndrome (LSS) in India

Loose shell syndrome (LSS) of shrimp, in which the meat in the tail portion of the shrimp appears shrunken inside the carapace, was first noted in 1996 but significant losses were not experienced until 1998 (Figure 2). The number of farms affected has increased over the past five years, and it is now regarded as a major factor affecting shrimp farm profitability.

Studies into the syndrome have been hampered due to the lack of a clear, consistent case definition and conflicting information as to cause. No pathogen has been identified and so transmission studies have been impossible. This made research into the problem very difficult and few studies have been reported on the disease, its development and control strategies.

As a result of industry concerns and to coordinate efforts between the public and private sectors, the newly formed Society of Aquaculture Professionals (SAP) conducted a survey in early 2004 to investigate LSS. The survey objectives were to:

- understand the occurrence and severity of LSS in shrimp farms;
- identify biological and environmental factors and conditions that are associated with LSS; and
- understand the views of farmers, farm technicians, farm consultants and technical support staff from farm suppliers on possible causative factors.

Although the conduct of the survey suffered from some constraints, the survey was able to identify to some extent, the scale of the problem and some potential factors associated with the syndrome. The survey results, as well as the results of some research projects supported by the SAP, were presented and summarized in a specially convened workshop, again funded and organized by the SAP. The workshop participants discussed and prioritized possible causes of the syndrome and established a clearer working case definition. The SAP then agreed on an investigative strategy and arranged for samples to be collected and submitted to pathology laboratories in India and other countries such as Thailand and the United States for more detailed analysis. In order to coordinate the investigations, the SAP also established a smaller "Task Force" of farmers, consultants and private laboratories whose responsibility was to follow up on the investigation and report to the SAP and its members.

The efforts of the SAP in dealing with LSS have been undertaken largely using their own funds and resources. However, as in the Thai case study, this example clearly demonstrates the role that the private sector can play in dealing with emergencies. Experience gained in such situations provides an invaluable resource for the development of contingency and preparedness plans for subsequent disease emergencies and represents an important resource for the development of official response strategies.

CONCLUSIONS

A few observations can be drawn from these case studies:

- The experience gained by the private sector in dealing with disease outbreaks is an invaluable resource in contingency planning and response to disease emergencies. It is essential that such experience is utilized if an efficient and effective response is to be developed.

- If an emergency response plan is to be effective, it must be prepared in consultation with the private sector. Greater involvement of the private sector in the development of preparedness plans and the control measures to be implemented will increase the likelihood that it will understand the need for such plans and its role and responsibilities within the emergency response.
- Effective involvement of the private sector requires its role be clear and that it understand the objectives and activities within the plan and how they relate to those of other agencies.
- Where the private sector is well-organized, it is capable of developing strategic plans, either on its own or in collaboration with government agencies.
- Although the lead role in such organizations is usually taken by wealthier, better-educated players, smaller farmers usually benefit from the knowledge gained and implementation of better health management strategies.
- Different stakeholders in the private sector will work together to solve common problems where these are perceived to be a threat to the entire industry rather than a threat to a limited number of players or sectors.
- In higher value species, more financial resources are available from within the industry itself, and these can be committed under circumstances where the industry is under threat. Even where money is not available, "in-kind" support can provide a significant resource in emergency response.
- Effective collaboration between the public and private sectors requires good communication between the two. With appropriate guidance and training, the private sector can play a significant role and provide a valuable partner for government agencies.
- Private-sector training in disease emergency preparedness and response is an essential part of the risk communication and risk management processes. Such training should be included in any development plan and should involve the public and private sectors, both individually and jointly.

Protecting aquatic biodiversity through health management and risk analysis: on-going initiatives and future prospects

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ABSTRACT

This discussion paper reviews some of the activities related to protecting aquaculture and aquatic biodiversity from transboundary aquatic animal pathogens (TAAPs) that have recently occurred or are being planned for the Asia-Pacific Region. It also speculates on where aquatic animal health in the region is headed in the next few years.

INTRODUCTION

The impacts of transboundary diseases on cultured stocks of aquatic animals are often well documented, due to the fact that in semi-intensive and intensive aquaculture production outbreaks of disease and associated mortalities are readily observed and the losses, in terms of numbers of dead animals and their monetary value, are easily quantified when ponds or cages are harvested. In contrast, the impacts of exotic diseases on wild populations of aquatic animals are less easily seen, as moribund animals are easy prey and may be quickly taken by piscivorous fish, birds and mammals. Additionally, accurate quantification of losses is usually impossible, as estimates of original population size are often not available, and any impacts on host population structure and aquatic biodiversity are difficult to measure, due to the problems inherent in working with natural ecosystems. Nonetheless, aquatic animal health workers are beginning to realize that the impacts of exotic diseases on wild populations of fish, shellfish and molluscs may be more significant, in terms of economic and social losses and long-term ecological impacts, than diseases confined to aquaculture systems (see, for example, Arthur and Subasinghe, 2002). This discussion paper will review some of the activities related to protecting aquaculture and aquatic biodiversity from transboundary aquatic animal pathogens (TAAPs) that have recently occurred or are being planned for the Asia-Pacific Region. It will also speculate briefly on where aquatic animal health in the region is headed in the next few years.

RECENT INITIATIVES

Aquatic animal health has recently become a rather dynamic field, thanks to outbreaks of serious transboundary diseases affecting the aquaculture industry, and to international efforts by the World Trade Organization (WTO) to remove barriers to free trade, while also providing the mechanisms for member countries to protect national human, animal and plant health (the Sanitary and Phytosanitary Agreement). These events have led to a large number of recent initiatives on reducing the risks due to transboundary aquatic animal pathogens, including the use of risk analysis as a decision-making tool, and to efforts to link concerns related to transboundary aquatic animal pathogens (TAAPs) to the larger concerns associated with aquatic invasive alien species (aquatic IAS) in the Asia-Pacific Region. This section highlights some of these activities.

Risk analysis initiatives

Good risk analysis is fundamental to protecting national aquaculture, capture fisheries and biodiversity from the adverse impacts of aquatic IAS and TAAPs. However, while most Asia-Pacific countries now recognize this fact, many are still struggling with how to move beyond theory to actual practice. Thanks to a number of recent regional meetings and activities, risk analysis procedures are becoming widely understood in the Asia-Pacific Region and are increasingly being adopted by countries as a way to reduce possible ecological, pathogen and genetic risks associated with international trade in live aquatic animals and their products.

A major step forward in this direction was the Asia Pacific Economic Cooperation (APEC) Fishery Working Group (FWG) Project on Capacity and Awareness Building on Import Risk Analysis for Aquatic Animals (FWG/01/2002), which included Asian and Latin American regional meetings on risk analysis that were held in Bangkok, Thailand and Mazatlan, Mexico. The primary outputs of this project were a volume containing the proceedings of the two meetings (Arthur and Reantaso, 2004) and a risk analysis manual designed for use by developing countries (Arthur *et al.*, 2004), documents that will prove useful to developing countries when starting risk analyses.

The World Organisation for Animal Health (OIE) has also recently published a two-volume set on qualitative and quantitative import risk analysis for animals and animal products (see Murray *et al.*, 2004; Murray, 2004).

Another extremely useful document for those attempting a first risk analysis is the Government of Australia's "Draft Import Risk Analysis Guidelines" (AFFA, 2001).

Most encouragingly, several risk analyses have recently be undertaken by countries in the Asia-Pacific:

- In April 2004, the Secretariat of the Pacific Community (SPC) contracted a team of five scientists with expertise in aquatic animal health, aquatic ecology and crustacean biology to undertake two risk analyses involving the proposed introduction of two crustaceans to SPC member countries for aquaculture

MANUAL ON RISK ANALYSIS FOR THE SAFE MOVEMENT OF AQUATIC ANIMALS (FWG/01/2002)

Import risk analysis procedures are elaborated development. These included the proposed movement of postlarval giant river prawn (*Macrobrachium rosenbergii*) from Fiji to the Cook Islands, and of postlarval blue shrimp (*Litopenaeus stylirostris*) from Brunei Darussalam to Fiji (see Arthur *et al.*, 2004; Bondad-Reantaso *et al.*, 2004). The analyses have been completed and the full risk analysis reports are expected to be available in the near future from the SPC website (www.spc.org.nc).

- The Department of Fisheries, Government of Thailand, has recently completed a risk analysis for the importation of white shrimp (*Litopenaeus vannamei*) to Thailand. Unfortunately, the report is currently only available in the Thai language.
- In additional to a number of completed import risk analyses, the Government of Australia has several aquatic animal risk analyses in various stages of completion. These comprehensive analyses provide excellent examples of approaches to risk analysis and a wealth of information on hosts and pathogens for many species of concern to developing countries in the Asia-Pacific Region. Draft copies available from the AFFA website (www.affa.gov.au/content/publications.cfm) include:
  - Current import risk analysis: freshwater crayfish
  - Current import risk analysis: freshwater finfish
  - Current import risk analysis: non-viable bivalve molluscs
  - Current import risk analysis: prawns and prawn products

Health management initiatives

South East Asian Fisheries Development Center Aquaculture Department's (SEAFDEC-AQD) Regional Fish Disease Project

The goals of this project, which was initiated in 2000 and is funded under the Government of Japan's Trust Fund's Regional Fish Disease Control Project (see Nagasawa, 2004), are to promote disease-free aquaculture in Southeast Asia and healthy and wholesome trade of aquaculture products; to develop standardized diagnostic methods for important diseases of cultured organisms in Southeast Asia, and to establish a disease surveillance system. Phase I of the project, "Development of Fish Disease Inspection Methodologies for Artificially Bred Seeds", will complete in 2004, with Phase II of the project, entitled "Development of Fish Disease Surveillance System", expected to run from 2004 – 2008.

The project has the following components:

- research to develop standardized diagnostic methods for the region, disease control husbandry techniques, and monitoring methods for residual chemicals in aquaculture products;
- an international workshop for the regionalization of the standardized diagnostic methods, as well as disease control husbandry methods;
- hands-on training on diagnostic methods for important viral diseases in the region; and
- development of a surveillance system for disease problems in the region.

Ongoing research includes studies on the establishment and standardization of diagnostic methods, the biology and pathogenesis of disease agents, disease prevention and control, and establishment of evaluation methods for residual pesticides in aquaculture products.

The project has organized two regional meetings:

- the "SEAFDEC-OIE Seminar-Workshop on Disease Control in Fish and Shrimp Aquaculture in Southeast Asia: Diagnosis and Husbandry

Disease Control in Fish and Shrimp Aquaculture in Southeast Asia - Diagnosis and Husbandry Techniques

OIE

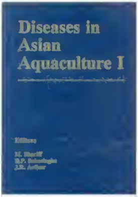
Disease control techniques are developed

Techniques", held in Iloilo in December 2001 (see Inui and Cruz-Lacierda, 2002); and

- the "Meeting on Current Status of Transboundary Fish Diseases in Southeast Asia: Occurrence, Surveillance, Research and Training", held in Manila in July 2004 (see Lavilla-Pitogo and Nagasawa, 2004).

It also recently co-organized, with the Fisheries Research Agency of Japan (FRA), the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF) and the OIE, the "International Symposium on Koi herpes virus Disease, which was held in Yokohama in March of 2004.

One of the stated goals of the project is to coordinate its activities with the Food and Agriculture Organization of the United Nations (FAO) and the Network of Aquaculture Centres in Asia-Pacific (NACA), through presentation of meeting results at the invasive aquatic species meeting in Penang and the current workshop in Jakarta.



Diseases in
Asian
Aquaculture I

Regular conferences are held and proceedings published

The Fish Health Section, Asian Fisheries Society

The Fish Health Section (FHS), which was formed in 1989, organizes the triennial "Symposium on Diseases in Asian Aquaculture" series, with the next meeting, DAA VI, being planned for October 2005 in Sri Lanka.

It also publishes the Fish Health Section Newsletter (http://afs-fhs.seafdec.org.ph) as a means of keeping members current on aquatic animal health happening in the region and world-wide. The FHS also occasionally coordinates projects of interest to its members and publishes technical documents thorough its special reports series.

NACA/FAO activities

Much of the recent activities in aquatic animal health at the regional level are continuations or direct offshoots of FAO's and NACA's seminal and catalytic regional project TCP Project - "Assistance for the Responsible Movement of Live Aquatic Animals", which provided the countries of the region with detailed expert guidance for developing national and regional strategies for reducing the risks of disease due to transboundary movement of live aquatic animals. The TCP Project was an extensive consultative process, undertaken between 1998-2000, involving input from government-designated National Co-ordinators (NCs), NACA, FAO, OIE, and regional and international specialists. The primary output, the final Technical Guidelines, was unanimously endorsed at the Final Workshop on Asia Regional Health Management for the Responsible Trans-boundary Movement of Live Aquatic Animals, held in Beijing, PR China, 27–30 June 2000. The major outputs of the project were:

- The Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and The Beijing Consensus and Implementation Strategy (FAO/NACA, 2000);
- the Manual of Procedures for the Implementation of the Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals. (FAO/NACA, 2001); and
- the Asia Diagnostic Guide to Aquatic Animal Diseases (FAO, 2001).

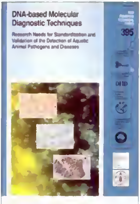
Most of the on-going supporting activities undertaken by NACA and/or FAO, with the assistance and participation of many other agencies and national governments,

Asia Diagnostic Guide to Aquatic Animal Diseases
Asia regional technical guidelines on health management for the responsible movement of live aquatic animals and the Beijing consensus and implementation strategy
402

Health management guidelines and diagnostic manuals are prepared

directly relate to one or more of the major components of the Technical Guidelines, i.e. disease diagnosis, surveillance and reporting; national and regional policy and planning; legislation, risk analysis, training and capacity building etc. Some examples include:

- The FAO/NACA/OIE Quarterly Aquatic Animal Disease Reports (Asia-Pacific Region)
- The Aquatic Animal Pathogen and Quarantine Information System (AAPQIS) (www.aapqis.org)
- The meetings of the Asia Regional Advisory Group (AG) on Aquatic Animal Health. This group of technical experts provides expertise and technical support to the Quarterly Aquatic Animal Disease Reporting System, to AAPQIS and to the Diagnostics Guide.
- Guidance on DNA-based molecular diagnostic techniques (see FAO, 2000)
- Guidance on disease surveillance and zoning (see FAO, 2004a)
- Guidance on emergency response to aquatic animal disease outbreaks (via the Regional Workshop on Preparedness and Response to Aquatic Animal Health Emergencies, Jakarta, September 2004 – this volume)
- Network on grouper diseases
- The Asia-Pacific Regional Programme on Mollusc Health Management
- Support to developing capacity and expertise in risk analysis (see above)
- Support for a series of fish parasite country checklists (Philippines, Bangladesh and Viet Nam have been completed (FAO 1997, 2002, 2004b); lists for Malaysia and Singapore are in progress)
- Various national TCP projects to support strategic planning, policy development, legislation, emergency response etc.
- Technical Guidelines for the Safe Transboundary Movement of Aquatic Animals, in support of FAO's Code of Conduct for Responsible Fisheries (CCFR)
- Initiatives to incorporate transboundary aquatic animal pathogens (TAAPs) into the mainstream of thought and activities related to aquatic IAS (see below).


DNA-based Molecular Diagnostic Techniques
Research Needs for Standardization and Validation of the Detection of Aquatic Animal Pathogens and Diseases
395

Research needs on diagnostics are evaluated

TAAPs and aquatic IAS – a meeting of the minds

Until recently, scientists, environmentalists, policy-makers and others with concerns about free-living invasive aquatic species (fish, molluscs, crustaceans, plants etc.) and those working with exotic pathogens of aquatic animals (aquatic animal health specialists, epidemiologists etc.) had little contact and indeed, the two areas were treated as almost mutually exclusive. However, this situation is changing, as both groups have recently realized their many commonalties, and it is beginning to be accepted that TAAPs are, in fact, a large (albeit highly specialized) subgroup of invasive aquatic species. A recent meeting held in Malaysia has done much to bring the two groups closer together.

NACA/ASEAN/FAO/World Fish Center/United States Department of State Workshop on "Building Capacity to Combat Impacts of Aquatic Invasive Alien Species and Associated Trans-boundary Pathogens in ASEAN Countries"

This innovative workshop was held 12-16 July 2004 in Penang, Malaysia. The workshop, which was hosted by the Malaysian Department of Fisheries, brought together experts on TAAPs and those from the broader community of scientists, environmentalists and policy-makers dealing primarily with free living aquatic invasive alien species (aquatic IAS). The 75 participants included delegates from Association of South East Asian Nations (ASEAN) member countries, resource persons with experience in IAS and aquatic animal pathogens, and representatives of regional and international organizations, research institutes, universities and the private sector.

The workshop was convened specifically to better understand the relationship of aquatic IAS and pathogens and their impacts (both positive and negative), and to identify management and capacity building needs to reduce risks. The workshop built on the recommendations from a 2002 Bangkok workshop organized by the Global Invasive Species Program (GISP) and a 2003 workshop of countries sharing the Mekong watershed, particularly in promoting awareness, establishing coordination mechanisms and information exchange systems and identifying management strategies and risk mitigation measures for aquatic IAS.

While recognizing that positive social and economic benefits have come from the introduction of some alien aquatic species, the participants concluded that aquatic IAS and invasive aquatic animal pathogens (i.e. TAAPs) significantly impact aquaculture and have negative implications for aquatic biodiversity and the social and economic well being of people in the ASEAN region. The major recommendations of the workshop were:

- Management of aquatic IAS and associated pathogens is imperative and should be encouraged and implemented in all ASEAN countries.
- National strategies should be developed consistent with obligations under existing international treaties and instruments and in harmony with strategies for other IAS, including aquatic plants and ornamental fish. National strategies, coordinated through national focal points, should be based on impact assessment and management of alien species, where they are already established, and use of ecological and environmental risk analysis for proposed new introductions.
- National strategies should be implemented within a legitimate regional framework supported and endorsed by ASEAN. The recommendations in this Way Forward summary should be presented to the ASEAN Secretariat as a starting point for coordinated regional action, through the ASEAN Sectoral Working Group on Fisheries and other appropriate bodies.
- ASEAN member countries should have the necessary institutional and human resources to adopt a harmonized regional strategy. Bridging development gaps and capacity building across member countries is therefore necessary. Special attention should be given to capacity building among the Mekong basin countries of Cambodia, Lao PDR, Myanmar and Viet Nam.
- In-country IAS impact assessment and risk analysis training should be promoted and implemented to establish core expertise in these practices in all ASEAN countries. Experiences in risk analysis and impact assessment should be shared among ASEAN countries.

- Networking, information exchange and cooperation among concerned agencies, industry, trading partners and countries sharing common watersheds or waterways is recommended for cost-effective use of resources in support of ASEAN in achieving the goal of effective management of aquatic IAS and associated aquatic animal pathogens.
- Assistance should be sought from regional and international organizations to implement the workshop recommendations, including from the organizers and participants of this workshop and other regional and international organizations. Progress in implementing the workshop recommendations should be assessed in three years.

Future directions

Risk analysis, which has already been used informally or formally by several countries in the Asia-Pacific Region, will become a standard procedure for countries to assess proposals for the introduction or transfer of aquatic species. The lack of knowledge on the identities, geographic distributions and biology of many pathogens of major cultured species should lead to increased government and donor support to targeted studies on key species, for good risk analyses depend on the availability of good data. Likewise there are many knowledge gaps relating to the ecology of introduced aquatic species, such that prediction of their likely impacts in new ecosystems must be based on many uncertainties. International trade in aquatic animals should thus, by necessity, lead to increased support for studies on the biology and pathogens of the species to be traded.

Increasingly, the risk analysis process will become more integrated and standardized, encompassing analysis of ecological, genetic and pathogen risks within a single framework.

The use of specific pathogen free (SPF) species, so far only developed for marine shrimp, should be extended to other widely traded species (e.g. tilapias, giant river prawn, common and koi carps). The number of pathogens for which stocks can be certified as SPF should be increased, production procedures (including disease testing procedures) should become more standardized across the industry, and guarantees of freedom from specific pathogens more strongly written and demanded. A standardized regional certification procedure for SPF and/or high health (HH) production of broodstock and juveniles could provide developing countries with much needed assurances of disease status of imported animals and would assist in reducing risks due to pathogens to below national acceptable level of protection (ALOP). Thailand has already taken measures to implement, for a limited period of time, such a system for importations of broodstock of blue shrimp (*Litopenaeus vannamei*) at the national level.

Wider cooperation among trading partners in the Asia-Pacific will occur, insuring the accurate, comprehensive and timely information on country disease status is provided and that certification of production facilities is done to international standards. Smaller and/or developing countries in the region should increasingly pool limited resources with regards to expertise in areas like risk analysis and disease diagnostics. Initial steps in this direction have already been taken by SPC member countries and among countries in Southeast Asia.

Exporting countries that are not members of the OIE or that are OIE members but do not provide accurate or timely reporting of information on national disease status will increasingly be penalized via lost markets, as trading partners will determine that the importation of live aquatic animals produced by their hatcheries and farms entails an unacceptably high level of disease risk. This should lead to more timely and transparent sharing of information, and ultimately, to reduction of risks and pathogen transfer.

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Institutional and regulatory frameworks for better preparedness for aquatic disease emergencies

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ABSTRACT

This paper discusses the international and Asia regional context of emergency preparedness for serious aquatic animal disease outbreaks. Examples of national approaches to regulatory frameworks for emergency preparedness for aquatic animal disease outbreaks are drawn from several developed countries (Canada, Japan and Australia). A brief review of the current Indonesian situation is made and some recommendations for improving the ability of the country to deal with aquatic disease emergencies are made.

INTRODUCTION

No country can develop aquaculture practices that eradicate the chances of future diseases in its fish farming. Diseases in fish will inevitably occur, and thus fish-farming nations should understand that they cannot guarantee a permanently disease-free aquaculture and that they must therefore prepare themselves for disease outbreaks. When combating a disease in aquaculture, a state has two major objectives: (i) controlling the disease as soon as possible and (ii) minimizing its damages. Currently, various countries have, thorough their legislation, implemented strategies to achieve one or both of these goals. This paper will illustrate a number of approaches, each one providing certain benefits for better emergency response to disease in aquaculture.

Nowadays it would be erroneous to ignore the international context in which national regulation of fish health takes place. International (global, regional and subregional) issues have grown in importance in recent years because of the interdependence of states in the trade arena, namely because of the transboundary movement of aquatic animals (and plants) for aquaculture and the aquarium trade. This has also led to a growing recognition on the part of national governments of the need or the obligation to base their own principles and standards on those prepared under the auspices of international organizations and in harmony with those prepared in other countries. Efforts to find solutions to the problems caused by movements of live fish (in particular, the spread of fish disease) have also boosted interest in collaboration in the subregional, regional and global arena in the area of fish health. A number of regional and international organizations offer guidance or other forms of advice, and serve as fora for governments and other parties to discuss and resolve fish health related concerns. Their activities, although trade driven, play a role in facilitating prevention and control of fish disease occurrence and spread, thus including better preparedness for aquatic diseases emergencies.

Finally, this Regional Workshop takes place in the ambit of a TCP/INS/2905 project, the objectives of which are, *inter alia*, to enhance national regulatory frameworks and legislation, improve biosecurity measures and strengthen national disease surveillance and reporting to reduce the risk of movement of pathogens, both nationally and internationally, through the movement of live aquatic animals. It is therefore appropriate to say a few words about the legal and institutional framework in Indonesia, where the government has introduced aquatic animal quarantine procedures with a view to monitoring and controlling disease outbreaks, as well as to regulating the movement of aquatic animals both locally and internationally.

THE INTERNATIONAL CONTEXT

A few organizations serve as fora for governments and other interested parties to discuss and resolve fish health related concerns or which produce and disseminate guidelines or other forms of advice. Some of these have important implications for fish health related issues, in that they assist in formulating countries' laws and regulations on fish health management. Furthermore, international and regional approaches are essential in dealing with and identifying epidemiological responses to aquatic animal diseases.

World Trade Organization

The World Trade Organization (WTO) was created on 1 January 1995 following the latest and largest negotiation round, i.e. the Uruguay Round of Multilateral Trade Negotiations from 1986 to 1994. This round incorporated not only goods but also services and intellectual property. At the heart of the WTO are a series of trade agreements, ministerial decisions and declarations that provide the legal ground rules for international trade. Currently, there are about 60 such agreements, declarations and decisions in place. It is the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) that has the most important consequences for national fish health legislation.

The SPS Agreement sets out the rights and responsibilities of WTO members wishing to apply measures to protect human and animal life and health (sanitary measures) and plant life and health (phytosanitary measures). To minimize such measures' negative effects on trade, the SPS Agreement provides that they can be applied only to the extent necessary and must be based on an assessment of risk, taking into account scientific evidence, relevant processes and production methods, inspection, sampling and testing methods, specific diseases or pests, ecological and environmental conditions and, in the case of animal and plant life and health, relevant economic factors. Furthermore, national SPS measures must be applied in a nondiscriminatory manner, and they must be applied so that they do not constitute a disguised barrier to trade.

For animal and plant life and health, measures should be based on those standards adopted and recommended by the Office International des Épizooties (OIE, the World Organisation for Animal Health) and the International Plant Protection Convention (IPPC), respectively. Although the SPS Agreement acknowledges the limitations of means, it encourages the participation of Member States, in particular developing countries, in these international organizations, so that they can contribute to the formulation of sanitary and phytosanitary measures and have sufficient information to make decisions regarding the approval of international standards.

The main implication of the SPS Agreement for national legal frameworks is that as long as a Member State employs international standards in the formulation of its national measures, these are presumed to be consistent with the provisions of the SPS Agreement. However, member states are allowed to adopt measures that establish a higher level of protection than that provided by the relevant international standard if there is a scientific justification, based on risk assessment. Measures may not arbitrarily or unjustifiably discriminate between Member States where identical or similar conditions prevail, and importing Member States are obliged to accept the measures of other Member States as equivalent if the exporting country objectively demonstrates to the importing country that its measures achieve the importing country's appropriate level of protection (ALOP). The SPS Agreement also provides that Member States are to offer advance notice of any new or changed measures through national enquiry points, thus giving other Member States an opportunity to comment on them. Finally, Member States must take into account the special needs of developing countries, in particular the least developed countries, which are granted longer time frames for compliance with sanitary and phytosanitary measures.

In 2002, the World Bank and the WTO created the Standards and Trade Development Facility (STDF), a fund with the objective of enhancing the capacity of developing countries to participate in negotiations, to develop SPS standards and to implement those standards at the national level. The Food and Agricultural Organization of the United Nations (FAO), the World Health Organization (WHO) and the OIE, all with expertise in SPS issues, have joined the initiative. The STDF provides funds for technical assistance projects in developing countries that will draw on the expertise of these international organizations. Some of the projects have focused, for example, on strengthening the capacities of developing countries to participate in the development of plant and animal health measures, and by extension, helping them to meet those standards.

Office International des Épizooties

The Office International des Épizooties (OIE), or World Organisation for Animal Health, is an international organization created in 1924 and located in Paris, France. Its objectives are to guarantee the transparency of animal disease status in countries around the world and to collect, analyze and disseminate scientific veterinary information. OIE Member Countries, usually through their official veterinary services, commit to collecting information on animal diseases present in their territories, which the OIE then analyses and disseminates in order to facilitate prevention and control elsewhere. The OIE also provides expertise and technical support to Member Countries requesting assistance with animal disease control and eradication operations, including for diseases transmissible to humans (zoonoses). In addition, the OIE develops standards for international trade in animals and animal products.

Several commissions support the work of the OIE. Regional Commissions (Africa, Americas, Asia/Far East/Oceania, Europe and the Middle East) promote and organize activities at the regional level. Specialist Commissions study problems relating to epidemiology and the prevention and control of animal diseases and develop and revise OIE's international standards. The Specialist Commissions consist of members experienced in veterinary science and regulatory issues, elected by the International Committee and drawn from all regions. As such, the Fish Diseases Commission compiles information on diseases of fish, crustaceans and mollusks and their methods of control.

Historically, the international standards for animal health developed and adopted under the auspices of the OIE were not mandatory for its Member Countries.

Unregulated movement of aquatic species cause spread of diseases and pathogens

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However, after the establishment of the WTO and the coming into force of the SPS Agreement, the OIE became the principal reference body for international standards concerning animal health and accordingly, standard-setting rose in importance as a primary task of the OIE alongside its traditional role of reporting disease information and disease control methods. Since all WTO members (i.e. most OIE Member Countries) must comply with the SPS Agreement, the implementation of OIE standards in national legislation has become essential. Different standards may be applied only where the importing country demonstrates scientifically to the exporting country that national animal health conditions require standards over and above those established by the OIE.

The OIE's animal health standards are developed and revised by the OIE Specialist Commissions and are the result of a consensus of experts from OIE Member Countries.

The international standards prepared by the OIE for aquatic animals are collected in the *Aquatic Animal Health Code* and the *Manual of Diagnostic Tests for Aquatic Animals* (OIE, 2003, 2004). They have been developed in acknowledgement of the fact that the epidemiology of aquatic diseases and the methods of disease control differ from those of land animals. The Aquatic Code gives detailed definitions of the minimum health guarantees required of trading partners in order to avoid the risk of spreading aquatic animal diseases, and includes sections on import risk analysis and import/export procedures. It also contains sections on health control and hygiene, and includes model international health certificates for trade in live and dead aquatic animals.

An important development has been the growing recognition within OIE of the importance of the interrelationship between animal health and food safety. The OIE has also begun to focus on the prevention of animal diseases from a food safety point of view, even where the diseases may not affect animals at all (but only humans). The OIE recently created the term "animal production food safety" to reflect this new field, which captures the importance of reducing risks to human health through effective measures imposed even before the slaughter of animals and the primary processing of their products. These developments have recently led towards greater collaboration between OIE and Codex and in particular, towards improving the current level of OIE input into Codex Alimentarius texts and to develop a method for the most effective utilization of Codex expertise in the work of OIE ad hoc groups. However, the likelihood for such developments to take place in the area of aquatic animal disease is very small, primarily because the aquatic animal diseases listed by the OIE are not diseases affecting human health.

International Organization for Standardization

The International Organization for Standardization (ISO), an international nongovernmental organization (NGO) that was created to "facilitate the international coordination and unification of industrial standards," is also active in areas related to fish health. Under development is ISO 22000, the Food Safety Management Standard, which will define the requirements for a food safety management system that covers the whole food chain from farm to fork. The extent to which this new development is likely to impact on fish health related matters is still to be seen.

Regional initiatives

Various initiatives have also been undertaken in Asia under the auspices of various organizations, including FAO, the Network of Aquaculture Centres in Asia-Pacific (NACA), OIE, and the Association of South East Asian Nations (ASEAN), as well as the South East Asian Fisheries Development Center (SEAFDEC) and the South East Asia Ministers of Education Organization (SEAMEO). Indonesia has been a strong participant in many international and regional activities aimed at preventing the transboundary spread of serious fish diseases. For instance, it participated in the FAO/NACA/OIE Regional Programme for the Development of National and Asia Regional Technical Guidelines on Health Certification and Quarantine for the Responsible Movement of Live Aquatic Animals and the ASEAN-organized Regional Seminar on the Harmonization of Quarantine Procedures for Live Fish, held 24-26 February 2003 in Penang, Malaysia, which led to the preparation of "Draft Guidelines for Harmonization of Quarantine Procedures of Live Fish among ASEAN Member Countries". There are also some on-going regional initiatives aimed at creating awareness and enhancing capacity building activities in the region. To illustrate this, there is the NACA/FAO/OIE Quarterly Aquatic Animal Disease (QAAD) Reporting System, which provides up-to-date information on important aquatic animal diseases in the Asia-Pacific Region. Such information is important as a "warning" and for purposes of risk assessment. Under the auspices of NACA, a Regional Advisory Group on aquatic animal health has been established. It meets annually and provides specialist advice, especially on emergency diseases of concern to governments (see www.enaca.org).

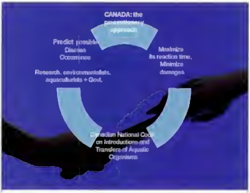
NATIONAL LEGISLATION AND PREPAREDNESS TO EMERGENCY SITUATIONS

A large number of countries have adopted legislation concerning fish health with the view to controlling disease outbreaks and limiting the damages thereof. We have identified three countries whose legal and institutional framework presents such characteristics and particularities as to enable them to prevent and control efficiently fish diseases and to be prepared for emergency situations.

Canada and the adoption of the precautionary approach

The best way to prepare for an emergency is to prevent one from ever occurring. In aquaculture, the way to prevent an emergency from occurring requires not letting a situation become an emergency. National authorities should take steps to try to predict accurately what diseases will most likely emerge in aquaculture. Hence, when the foreseen disease does hit, it won't be a real emergency; the country already knew it was coming and had prepared ahead of time. Rush decisions will be avoided. Thinking about a problem ahead of time lets the legislator think with a calmer mind and gives it time to consider all possible effects of a disease occurring in the fish farms. In other words, if a country adopts and carries out the precautionary principle or precautionary approach, it can maximize its reaction time to aquaculture disease and minimize the damages.

Canadian policies demonstrate proper execution of the precautionary approach. Explicitly evident in its *National Code on Introductions and Transfers of Aquatic Organisms*, the country systematically takes a precautionary approach towards aquaculture disease (see Anon., 2003). The legislator has not simply decided to sit down and wait. Instead, as explicitly stated on the Web site of Canada's Department of Fisheries and Oceans (DFO), its scientific research and international trade policies


CANADA: the precautionary approach
Predict possible Disease Occurrence
Maximize its reaction time, Minimize damages
Research, environmentalists, aquaculturists + Govt.
Canadian National Code on Introductions and Transfers of Aquatic Organisms

Canadian policies demonstrate proper execution of precautionary approach

are geared towards implementing efficient fish disease control procedures. The DFO proclaims it wants "Canada as the world leader in sustainable aquaculture". To achieve this goal, the fishery ministers of each province have mutually agreed to strive towards "technological advancements, capacity for innovation and a highly knowledgeable labour force" (see www.dfo-mpo.gc.ca/home-accueil_e.htm). Canada's DFO seems to realize that to prepare itself successfully ahead of time for fish diseases, it needs to have policies based on the best available technology and have scientific findings done by researchers who actually have knowledge in the field of aquaculture. There would be no point to foreseeing diseases if the predictions had no accuracy.

Obtaining different perspectives can help diffuse a stronger precautionary principle. Canada's DFO seeks to involve not only the government, but also environmentalists and aquaculturists in "maintaining the healthiest and most disease free environment for fish, either wild or cultured". By turning to different schools of thought, all of which have an interest in controlling fish disease, Canadian legislation avails itself to more sources of information. More information will likely form more accurate and well-thought out policies and assist the legislator in taking more factors into account. Given Canada's wide-ranging economic dependency on aquaculture, the DFO admits that it must take in as much information as possible when making decisions and passing regulations. If a national legislation considers as many factors as it possibly can before an actual disease occurs in its fisheries, the country will face less surprises and thus have less emergencies to overcome.

Japan: sharing power

National legislation can go beyond turning to nongovernmental sources for information. It can write laws that allocate some of the powers and responsibilities related to fish disease control to entities such as fishery associations or universities. Japan's legislative body exemplifies power-sharing. It displays how breaking down responsibility can benefit emergency response by minimizing the damages caused by a sudden disease outbreak.

Japan's national government shares powers relating to the management of fisheries, including aquaculture, as a mechanism to reach its aquaculturists. Aquaculture responsibilities are meted out to Japan's prefectural governments, which pass some of their authority on to fishery cooperatives. The 15 member fishery cooperatives consist of nine highly experienced fishers/aquaculturists, two local authority representatives and four scientists (see www.arc-corp.co.jp/JIFRS/English/CBFMinJapanFinal.htm).

A primary purpose behind fishery cooperatives is to have a governing body at the community level. Among their various duties that relate to fisheries, including aquaculture, the cooperatives exercise authority over aquaculture rights and issues relating to fish farming. Japan's national government takes advantage of the existence the local fishing/aquaculture community body and uses it as a tool for better emergency preparedness. Involving local, community-level entities in fish disease control is valuable because fish farmers have the closest and most consistent contact with the disease-stricken aquaculture. To control disease in aquaculture, a government ultimately will have to turn to the individuals who actually do the farming. To initially find out about the occurrence of disease in its aquaculture, a government most likely has to rely on its fish farmers for reports. To enforce its aquaculture regulations, a national government needs to make sure its community base, the fish farmers, carries them out. Just as a government needs its fish farmers in the daily enforcement of fish disease control, it needs them for emergency response situations.

Japan does not stop at involving its fishers/fishfarmers' communities. To combat fish farming diseases, Japan's national government has entrusted certain responsibilities to the Japan Fisheries Conservation Association (JFCA), the Japan Veterinary Medical Association and select graduate universities (see Inouye, 2003). The JFCA has the duty of "establishing uniform techniques for disease control". Under the umbrella of this duty, it has authority for technical extension, training and the inspection of imported live fish. In recent times, Japan's government has also started turning to the association to train fish disease technical workers. But for training specialists and technical workers, the government's Fishing Agency predominantly looks to the universities with veterinary or fishery faculties or to Japan's Veterinary Medical Association. In addition, Japan's national government relies on the scientific NGO, the Asian Fisheries Society, to distribute scientific journals and provide financial or technical assistance to fish disease researchers. By leaving the job of training specialists and assisting researchers to different nongovernmental entities, Japan's national government can expect a stronger emergency response system. By sharing responsibilities, the national authorities have fewer obligations and thus can concentrate more completely on the other aquaculture-related matters it needs to deal with. Also, entities such as the JFCA probably devote more time to studying and designing disease control tactics compared to what the national government would have available. As a result, it will likely come up with better thought out and coherently devised techniques. In Japan's system, each step in the process of aquaculture disease control separately grows strong under the relevant authority. For example, the veterinary faculties and the Japan Veterinary Medical Association are better equipped than a national legislative body to guide veterinary training. With each step going strong separately, ultimately the whole process becomes stronger. While Japan's legislation may not act under the precautionary principle, by sharing responsibility, it can at least address an emergency from different angles simultaneously and minimize the damages that come with diseases in fish farming.

Australia: specificity

Optimizing fish disease control doesn't stop at sharing responsibilities. Even after a legislator allocates some of the powers related to aquaculture management, it still has to tackle the duties it has left reserved for itself. To handle their fish disease control duties, some governments have decided to break them down as much as possible within their own legislation. By creating tailor-made laws for each type of fish disease, the legislator creates a model for how to deal with future diseases that are similar to the legislated one. While this method does not allow a government to necessarily foresee a fish disease, it does allow it to have a template to follow once a new disease emerges. When having to respond to an emergency fish disease, the government with a guiding template can react faster and be caught less off-guard.

INDONESIA

The National Strategy for Fish Health Management

Indonesia has developed its current policy with regard to fish health through its participation in the recent FAO/NACA/OIE Asia-Pacific Regional Programme for the Development of Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals (see FAO/NACA, 2000). The general objective of the National Strategy is to standardize Indonesia's fish health management programme in order to promote adequate disease control methods in aquaculture production systems, contribute to the development of sustainable aquaculture, and fulfil Indonesia's obligations as a member of the international community (Rukyani, Harjono and Sunarto, 2003).

The Government of Indonesia intends to develop and implement policies, legislation and practices that are both scientifically sound and generally accepted by regional trading partners and the broader international community. The draft National Strategy identifies ten programmes, or broad areas of concern, that need to be addressed:

1. Surveillance, Monitoring and Reporting of Fish Disease
2. Fish Quarantine
3. Regional and International Collaboration
4. Fish Disease Control (Contingency Planning)
5. Public Awareness
6. Research and Development
7. Rules and Regulations
8. Institutional Framework
9. Fish Resource and Environmental Management for Aquaculture
10. Funding Resource

For each of the ten components of the programme, the draft strategy outlines objectives and benefits, current status, key issues and an action plan; the latter is actually a brief listing of specific goals or objectives that are desired (see Arthur, 2003).

International context

Indonesia is a party to a number of international agreements and arrangements dealing with issues relevant to fish health and live fish movements and consequently, has obligations and rights under these agreements. Indonesia is a member of OIE, WTO, and the International Maritime Organization (IMO) and is a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and to the Convention on Biological Diversity (CBD). At the regional level, Indonesia is a member of NACA, SEAFDEC and SEAMEO, regional intergovernmental organizations concerned with preventing the international spread of fish disease.

Furthermore, Indonesia has participated in a number of regional initiatives developed respectively under the auspices of the FAO/NACA/OIE Regional Programme and ASEAN. The active participation of Indonesia on the international and regional scene witnesses its willingness to deal with the issues of fish health, live fish movement and preventing the spread of fish diseases.

Legislation related to fish health management

There are currently more than 50 laws and implementing regulations (mainly "decrees") dealing with fish health related issues (see Prayitno, 2003). Besides, draft subsidiary legislation exists, along with a number of codes and guidelines. The subsidiary legislation includes Government decrees, Presidential decrees, Ministerial decrees and Orders issued by the Directorate General for Aquaculture, as well as Center for Fish Quarantine Instruction Letters. Many of these regulations, however, are or may be obsolete, even though they are still technically in force, as they have never been formally repealed.

The Law No. 16 of 1992 concerning Animal, Fish and Plant Quarantine constitutes the framework law for the quarantine of animals, fish and plants for domestic and international movements. It sets the basic principles for the development and implementation of various quarantine actions with respect to the transit and import/export of live aquatic animals within and in and outside the country. This law has been implemented and is supplemented by the Government Decree No 15 of 2002 concerning fish quarantine. As its title suggests, it deals with fish quarantine and health certification. It goes much more into detail than the basic principles laid down in the Law of 1992. Composed of 12 Chapters, it consecutively deals with: General provisions; Quarantine requirements, Quarantine actions in case of entry, export, transit, mooring and landings in case of force majeurs etc.; Quarantine zones; Quarantine pests and diseases of fish and the carrier; Places of entry and exit/designation; Quarantine officers/competencies and installation; Quarantine Service tax; Development of quarantine awareness/community participation and Inter-country cooperation.

A quarantine action is defined as "the actions as the effort to prevent the introduction into, dissemination from one area to another within, or the exportation from, the territory of the Republic of Indonesia of quarantine pests and diseases of fish." Health certificates must accompany any introduction into the country of or the transport within the country from one area to another of a fish and/or other article capable of carrying quarantine pests and diseases of fish (called "a carrier"). They are issued in case of export of a carrier, if the importing country so requires.

Reference is made to risk analysis requirements (art.3) and factors that need to be taken into account for purposes of defining the distributional range of the pest or disease. These factors include namely whether the pest or fish disease outbreak occurred naturally; the impact of quarantine requirements and actions on trade and transport of people and articles, cost-benefit analysis and government capability to prevent the spread of pests and diseases.

Besides these two very basic instruments, there is a myriad of regulations pertaining to the scope of the quarantine activities, the operational aspects, the import and export of specific aquatic species (CITES related), the monitoring and control of the national and international spread of certain serious diseases (e.g. Koi herpes virus) and institutional matters. To illustrate the latter, Orders have been issued by the Directorate General for Aquaculture concerning the establishment of a national task force to overcome freshwater fish diseases.[1]

The current legal framework allows the Ministry of Marine Affairs and Fisheries (MMAF) to implement effectively a national policy for fish health management, including quarantine and certification procedures. The myriad of regulations expresses the concern of the ministry to deal with fish health related issues, whether operational or institutional, with a certain degree of specificity; however the approach taken is often piecemeal and ad hoc, as the problems arise.

Law enforcement (surveillance, control and fish inspection) is a major constraint to fish health management in Indonesia. The problem is often reported by officials. Lack of equipment and financial resources, lack of training in fish health matters by enforcement officers, insufficient coordination and cooperation between the MMAF and other national and regional authorities, absence of a surveillance and monitoring plan and lack of clarity in the roles and responsibilities of agencies and departments involved in surveillance and control activities have been reported as the major constraints to an effective control and enforcement scheme in Indonesia. There is no need to reiterate such findings, which are primarily policy issues, but some key legal issues need to be addressed in the basic legal framework on fish health management, namely the designation of relevant control/enforcement officers and the determination of their powers. Indeed, special attention should be given to enforcement provisions in the law.

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[1] Directorate General of Aquaculture Decree No. 3750/DPBA/IK.220.DA/VIII/2002 Concerning the Formation of a National Team to Overcome Freshwater Fish Diseases; Decree of the Directorate General of Aquaculture No. 2101/2002 Concerning a National Task Force for Controlling Freshwater Fish Disease Problems (Carps, Gourami, and Others); Decree of the Directorate General of Aquaculture No. 2102/2002 Concerning the Establishment of a National Fish Health Commission.

Institutional framework: a myriad of institutions

A large number of national and provincial institutions are active in fish health management or have fish health related issues within their mandates. At the national level, within the MMAF, several primary units are mandated to deal with fish health:

- the Directorate for Fish Health and Environment under the Directorate General for Aquaculture;
- the Directorate of Fish Processing and Quality Control under the Directorate General for Capture Fisheries;
- the Center for Fish Quarantine under the Secretariat General;.
- the Agency for Marine and Fishery Research: Fish Disease Laboratory

A description of the respective mandates of these units can be found in the report of the International Consultant on Fish Health Management, Dr Arthur, under TCP/INS/2905 (see Arthur, 2003). Fish quarantine operational actions are conducted primarily by the Center for Fish Quarantine. The status of the latter is equivalent to the directorate. Suggestions were made to centralize the fish quarantine operational actions and related activities into one service, upgraded at the level of Directorate General, without distinction between capture fish and fishery products, aquaculture products or between import/export activities or movements within the country.

Some four expert commissions and committees have been established by the Directorate of Fish Health and Environment to address national fish health concerns; however, the purposes and tasks of these committees appear to be ill defined and overlapping.

Besides this central structure, there are a number (30) of Fish Quarantine Implementing Units (2 main fish quarantine stations, 7 regional fish quarantine stations, 10 fish quarantine stations Class I, 12 fish quarantine stations Class II and 1 Fish quarantine experimental unit). Some of these technical units are under both the Directorate General for Aquaculture and the Provincial Fisheries Services. In addition, there are some 380 checkpoints. These technical units are responsible for actual conduct of fish quarantine inspection and health certification. Quarantine checkpoints primarily check all shipments of live fish with a view to controlling the documentation, including the health certificates, accompanying the shipments. Discussions reported a need for development of expertise and capacity of the technical units to address fish health problems.

Other ministries play equally a role in international trade in live fish and products thereof. They are:

- the Ministry of Forestry, concerned with trade in endangered species and responsible for CITES-related matters;
- The Ministry of Health, concerned with fish food safety and fish as carriers of zoonotic diseases; and
- the Ministry of Trade, concerned with setting fees for trade in live fish and fishery products.

There are also some private developments, where ISO-approved companies are internationally recognized to issue health certificates.

Whether the implementation of the Autonomy Law has implications for the management of fish health is difficult to assess. However, uncertainty remains as to the nature and extent of the authority to be transferred from the central government to the various levels of local government. To ensure the success of the decentralization process, it is crucial that the relevant laws and regulations clearly spell out the nature and scope of the competence and powers to be transferred from the central government to provincial and district authorities. It is advisable that the MMAF prepares guidelines for the management of fish diseases and pests at the provincial level.

The primary weaknesses of the institutional structure lays in the lack of clear definition of the functions of the various authorities involved and the lack of communication

Establishing farmer associations helped control of KHV outbreaks in Indonesia

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between them. This seems to result in gaps and overlapping duties, from which interested parties (fish farmers, traders and others) benefit and suffer. Besides, several officers complained about the absence or lack of communication and networking between the various authorities involved. Lack of communication between the Directorate of Fish Health and Environment, the Center for Fish Quarantine and the Research Agency should be prevented if preparedness for emergencies has to be developed. Representatives of these institutions should meet on a regular basis to review progress made in dealing with important fish health related issues and generally speaking, once the National Strategy on Fish Health Management is adopted, to review its implementation. In other countries, universities (which provide scientific advice) and private-sector representatives have respective duties and opportunities to meet with government authorities with a view to addressing fish health related matters in order to increase the sustainability of aquaculture development and the industry's competitiveness in national and international markets and last but not least, prevent the occurrence of fish diseases and limit the damages caused by outbreaks. A forum should be identified where the private and public sectors could collaborate to use their findings in making decisions regarding regulations and industry practices, such as those relating to siting, feeding practices, introductions and transfers etc.

CONCLUSIONS

Guidelines and standards developed at the international level cannot be "imported" – they have to be tailored within specific national contexts. But regulatory problems can be shared among countries with similar circumstances, and so international and regional solutions devised and last but not least, trade can be improved. The last decade has witnessed a growing interest in the inter-relationship between food safety and other areas of agriculture, including fisheries, which were treated separately in earlier times, such as plant quarantine and animal quarantine. More recently, these topics happen to come under the heading "biosecurity," which is generally understood to mean protection from the environmental, economic and human health risks of potentially harmful organisms. At the national level, governments began to vest food safety, animal quarantine and plant quarantine authority in a single executive agency that carries out inspections "from farm to fork" and aims to protect animal, plant and human life and health. International developments have driven these changes. NACA further implemented, in collaboration with other international organizations, an APEC Fisheries Working-Group funded project (APEC FWG 01/2002) "Capacity and Awareness Building on Import Risk Analysis for Aquatic Animals." An important output is *the Manual on Risk Analysis for the Safe Movement of Aquatic Animals* (Arthur *et al.*, 2004).

Canada, Japan and Australia fall along the spectrum of emergency response. Canada seems the most ready. It structures its policies according to the precautionary principle. Together with an express aim of preventing diseases in aquaculture from occurring in the first place, it's Department of Fisheries and Oceans (DFO) reveals also elements of power-sharing and specificity. DFO involves environmentalists, aquaculturists and minority groups such as aborigines. With such a multifaceted approach, Canada strives to be the best equipped to deal with emergencies in fish farming because it maximizes its response time and minimizes disease-caused damages. While Canada tries to include all the possible actors related to aquaculture, including economists and environmentalists, Japan turns primarily to its fishers/aquaculturists. When Japanese fishery cooperatives make decisions about aquaculture, they rely on their members/fish farmers to compile information and report directly from the field. Japan, by sharing power, has prepared itself better for emergency situations because it will likely minimize damage. However Japan may not necessarily maximize its reaction time by sharing power. It can still be caught by surprise. Australia, on the other hand, through its very detailed and specified legislation, does save time because it creates guiding models for itself. Australia and Japan have focused efforts on what to do when a disease strikes fish farms. Canada, however tries to optimize its technology and research and policies ahead of time, before the disease occurs, so that it can be best equipped for when sickness does strike its fish farms.

Ultimately to succeed, emergency preparedness response legislation requires proper enforcement. Canada, Japan and Australia demonstrate what a country should do at the legislative level to prepare itself for diseases in aquaculture. But realistically, each one of these countries needs to have reliable enforcement techniques. For example, in the Canadian DFO, dedication to scientific advancement and research won't sufficiently guarantee the most up-to-date valid research; the scientists and researchers themselves need to display dedication and willingness to conduct research and undertake acute risk assessments. In Japan, looking to fishery association and fishery management organizations means trusting fish farmers to report occurrences of disease. While Canada, Japan and Australia may fall at different points along the spectrum of preparedness for emergencies in aquaculture, all three countries share one commonality: they must look to various actors for actual implementation. Scientists, enforcement officials and fish farmers need to be motivated to carry out relevant emergency preparedness response measures in aquaculture practices.

RECOMMENDATIONS FOR INDONESIA WITH REGARD TO FUTURE ACTIVITIES

Legislation may play a useful role to enhance responses to aquatic animal health emergencies. To this effect and with a view to promoting sound fish farming practices, combating fish disease occurrences and limiting their damage, the current laws and regulations of Indonesia should be carefully reviewed, reformulated and/or amended. Choices should be made: precautionary approach, power sharing, specificity or other? Such legislation should address a number of issues, like disease surveillance, control and eradication; contingency plans; new species introductions; domestic movement of live fish and their products; and fish inspection and quarantine. Besides, the challenge is also to design legislation that both enables and guides those (public and private sector) involved in fish health related activities. It should clearly redefine the duties of various authorities involved in matters of fish health at the national, provincial and district levels and promote effective coordination, power-sharing and communication between all those involved. The private sector should not be left behind. As providers of information and reports, fish farmers should be enabled to play a role in decision-making processes relating to the implementation of fish health management programmes.

The international agreements and regional guidelines set important parameters governing the adoption and implementation of fish health standards and measures.

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Capacity building for developing national and regional emergency prevention systems for transboundary aquatic animal diseases

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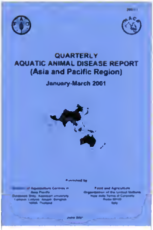
ABSTRACT

Transboundary movement of live aquatic animals is one of the principal reasons for increased disease emergencies in the Asia-Pacific Region. Disease emergencies may arise within a country in a number of ways: introductions of known exotic diseases, changes in the pattern of known endemic diseases or the appearance of unknown diseases. Contingency planning is critical to the effective management of such disease emergencies. A wide range of capacity and awareness building is required to effectively manage aquatic animal disease emergencies. This paper examines the capacity and awareness building needs of countries in the Asia-Pacific Region to deal with aquatic animal health emergencies and provides details of some of the key capacity and awareness building initiatives in the region. Further, the paper attempts to provide a general picture of responsibilities at the different stakeholder levels to implement effectively a contingency plan, and identifies the skills and capacity required to carry out the responsibilities.

INTRODUCTION

Threats to the sustainability of the aquaculture industry are numerous. Aquatic animal disease has been one of the most serious. Diseases caused by transboundary pathogens pose serious threats to aquaculture in many parts of the Asia-Pacific Region. Transboundary animal diseases are defined as epidemic diseases that are highly contagious or transmissible, with the potential for very rapid spread irrespective of national borders and which cause significant socio-economic and possibly public health consequences (Baldock, 2002).


QUARTERLY
AQUATIC ANIMAL DISEASE REPORT
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FAO/NACA quarterly disease report

Transboundary movement of live aquatic animals in the region is one of the principal reasons for increased occurrence and spread of several serious diseases (Subasinghe, Bondad-Reantaso and McGladdery, 2001; Bondad-Reantaso, 2004). Examples of diseases and pathogens introduced to new areas and hosts leading to serious consequences in the Asia-Pacific Region include epizootic ulcerative syndrome (EUS) in fresh- and brackishwater fishes, white spot syndrome virus (WSSV) and Taura syndrome virus (TSV) in cultured shrimp and viral encephalopathy and retinopathy (VER) in grouper. Common carp and koi mass mortalities in Indonesia since June 2002 and the confirmed outbreak of Koi herpes virus (KHV) in Japan (NACA/FAO, 2004) are further reminders of the dangers associated with the transboundary spread of pathogens. Important transboundary aquatic animal diseases positively reported based on the information recorded in 22 issues (1998 to 2003) of the Network of Aquaculture Centres in Asia-Pacific (NACA)/Food and Agriculture Organization of the United Nations (FAO)/World Organization for Animal Health (OIE) Quarterly Aquatic Animal Disease (Asia-Pacific Region) Reporting System (QAAD) is provided in Table 1. Careful examination of the history and spread of transboundary pathogens indicates how lack of effective surveillance systems and contingency plans can impact aquaculture and wild fisheries resources.

TABLE 1

Occurrence (+) of important finfish and crustacean transboundary diseases in the Asia-Pacific as reported in the NACA/FAO/OIE Regional Quarterly Aquatic Animal Disease (QAAD) Reporting System.

Disease[1]	EUS	VER	GID	KHV	WSD	TS
Country						
Australia	+	+				
Bangladesh	+				+	
Cambodia	+				+	
China PR					+	+
DPR Korea						
Hong Kong China		+	+			
India	+				+	
Indonesia	+	+	+	+	+	+
Iran					+	
Japan	+	+		+	+	
Lao PDR	+					
Malaysia	+	+			+	
Myanmar	+				+	
Nepal	+					
Pakistan	+					
Philippines	+	+			+	
Korea RO		+			+	
Singapore		+	+		+	
Sri Lanka	+				+	
Thailand	+	+			+	+
Viet Nam	+	+			+	+

[1] EUS=epizootic ulcerative syndrome, VER=viral encephalopathy and retinopathy, GID=Grouper iridoviral disease, KHV=koi herpes virus, WSD=whitespot disease, TS=Taura syndrome

CAPACITY AND AWARENESS REQUIRED FOR CONTINGENCY PLANNING, EARLY WARNING AND EMERGENCY RESPONSE

A disease outbreak emergency exists when a population of aquatic animals is recognized as undergoing severe mortality events, or there is otherwise an emerging disease threat where urgent action is required. Infectious disease emergencies may arise within a country in a number of ways, for example: introductions of known exotic diseases, sudden changes in the pattern of existing endemic diseases or the appearance of previously unrecognized diseases. Contingency planning, early warning and early response are critical to the effective management of such disease emergencies. In simple terms, emergency response involves implementation of a well thought out and agreed technical response plan to identify and deal with an aquatic animal disease emergency event. Preparedness should happen during "peace time" (i.e. when there is no disease). When there is an emergency, the response should proceed according to the plans that have been developed.

Contingency planning is an agreed management plan and set of operational procedures that would be adopted in the event of an aquatic animal disease emergency. For mounting an effective emergency response, governments should have the capability to develop contingency plans and build the required operational capacity (e.g. human resources) to implement the plan effectively. Industry should be involved and ideally, also be encouraged to have "ownership" of the plans. Some of the important components of a contingency plan include: technical plans (e.g. manuals on disease strategy, general procedures), support plans (e.g. financial, resource) and operational plans (e.g. management manual, diagnostic resources, training resources), all with clearly designated responsibilities. Through a well-documented contingency action plan agreed upon by all major stakeholders, it should be possible to minimize the impact of an aquatic animal disease emergency.

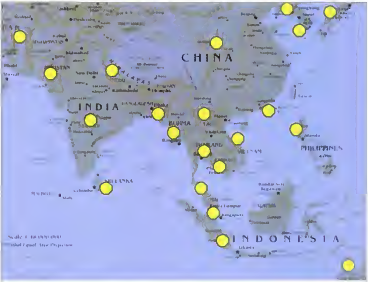
The aim of early warning is to rapidly detect the introduction of an exotic pathogen or a sudden increase in the incidence of any disease. For establishing an effective early warning programme, a strong technical capability at the national level is fundamental in the areas of disease diagnostics, risk analysis, disease surveillance, zoning, epidemiological analysis, aquatic animal health information systems, national and international disease reporting, and information communication and sharing.

Emergency response is identified as all actions that would be targeted at rapid and effective eradication/containment/mitigation of an emergency disease outbreak. The responses may be of different types depending on the disease agent and the likely impact. Some responses (e.g. only monitoring) may not cause any disruption to the culture operation, while some may cause some disruption (e.g. movement control, treatment, increased surveillance). Drastic responses (e.g. destruction of stock, emergency harvest) will cause major disruption to farming practices. Operational capabilities at different levels (farm/village/province/national) are vital to mount an effective emergency response.

Australia has developed an effective emergency preparedness and response programme known as The Australian Aquatic Animal Diseases Veterinary Emergency Plan (see AQUAVETPLAN, 2002). It comprises a series of manuals outlining national emergency preparedness and response and control strategies. The manuals provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency management plans. The Control Centers Management manual outlines the organizational response during an aquatic animal disease emergency event, addressing legislative, management and resource issues. The Enterprise manual describes the emergency response options available for control and eradication of aquatic animal diseases. It also provides a framework for assessing which strategy to use, taking into account several factors (e.g. type of pathogen, management practices and effectiveness of treatment). The Destruction manual guides the decision to destroy the stock, and the choice and application of appropriate techniques based on several considerations (e.g. type of animal, disease and production system, their end use, possibility of the disease infecting human beings). The Disposal manual provides guidance for safe transport and disposal of carcasses, animal products and wastes. These manuals are aimed at government and industry personnel who may be involved in emergency disease preparedness and response. Closer examination of these manuals helps to understand the extent of technical capacity building, infrastructure and financial resources that are required to support an ideal national emergency preparedness and response programme.

STATUS OF CAPACITY FOR AQUATIC ANIMAL HEALTH MANAGEMENT IN THE ASIA-PACIFIC REGION

The guiding principles in the "*Asia Regional Technical Guidelines on Health Management and the Responsible Movement of Live Aquatic Animals*" (or the "Technical Guidelines") and their associated implementation plan, "*the Beijing Consensus and Implementation Strategy*" (BCIS) (FAO/NACA, 2000), was adopted as a regional strategy by 21 governments in the Asian Region in the year 2000. Within Asia, the Technical Guidelines provide the basic framework and guidance for national and regional efforts in reducing the risks of diseases due to transboundary movement of live aquatic animals. The main elements of the Technical Guidelines are: guiding principles, pathogens to be considered, disease diagnosis, health certification and quarantine measures, disease zoning, disease surveillance and reporting, contingency planning, import risk analysis, national strategies and policy frameworks, regional capacity building and an implementation strategy. The framework provided by the Technical Guidelines is a comprehensive one that includes all major requirements for managing aquatic animal disease emergencies associated with transboundary pathogens.



Twenty one Asian countries participate in the NACA/FAO regional aquatic animal health management programme

TABLE 2
Assessment of progress made in the Asia-Pacific Region towards implementation of the Technical Guidelines.

Elements in the Technical Guidelines	Progress Made (Number of Countries)		
	Good	Moderate	Low
Disease diagnosis	8	8	5
Health certification and quarantine measures	10	5	6
Disease zoning	3	3	15
Disease surveillance and reporting	6	9	6
Contingency planning	3	6	12
Import risk analysis	2	5	14
National strategies and policy frameworks	11	4	6

Countries in the region are at different stages of development of the national aquatic animal health strategies that contain the action plans of governments and that form the basis for the national-level implementation of the Technical Guidelines. Despite the considerable progress accomplished in the region, there are still areas that need to be seriously addressed. An assessment of the progress made in the Asia-Pacific in the implementation of the various elements contained in the Technical Guidelines shows the present status and highlights the regional capacity building needs (see Table 2).

This analysis suggests that contingency planning is one of the weak points where capacity building is required.

CAPACITY AND AWARENESS BUILDING NEEDS AT THE NATIONAL LEVEL

For some countries in the region, capacity-building activities should initially focus on developing and implementing simple and practical national aquatic animal health management strategies incorporating the key elements contained in the Technical Guidelines. For countries already having practical national strategies, it should be easier to target resources and build specialist capacity for early warning and early response to tackle aquatic animal disease emergencies. Early warning and early response programmes embrace all initiatives, mainly based on risk analysis, disease surveillance, reporting and epidemiological analysis. Mere establishment of emergency preparedness programmes and frameworks without appropriate skill and capacity development would be of little value. Capacity and awareness building is required at different levels to carry out the various responsibilities:

- contingency planning (e.g. developing disease strategy manuals, general procedure manuals, enterprise manuals, job descriptions, support plans and operational plans);
- early warning (e.g. risk analysis, disease surveillance, epidemiological analysis, aquatic animal health information systems, national disease reporting, international disease reporting) ; and
- early response (e.g. national and local disease control centers, information systems, laboratory procedures, field guides, trained field staff).

Table 3 attempts to provide a general picture of responsibilities at the different levels, and the skills and capacity required to carry out the responsibilities. A wide range of capacity and awareness building is required to effectively manage aquatic animal disease emergencies. It is clear from experience that for most countries in the region, it is going to be a very difficult challenge to develop an ideal emergency preparedness and response programme. The capacity is inadequate in many countries in Asia due to several factors, such as limited diagnostic capacities, lack of information, insufficient human resources and infrastructure, and lack of financial resources.

In such a scenario, there is a need to look to other options. Countries should target resources to develop simple and practical contingency plans to deal with high-risk diseases (e.g. Koi herpes virus disease, Taura syndrome) that are likely to be introduced. Management of an aquatic animal disease emergency will require a collaborative and team approach. Opportunities for optimizing the existing resources at the national level (e.g. promoting collaboration with livestock services, which are usually well experienced in managing terrestrial animal disease emergencies) should be seriously explored. At the regional level, countries with experience should be encouraged to share information with other countries and help bridge the development gap. Countries can also use regional reporting systems to be more aware of the new diseases that may pose risk.

Provision of adequate resources is crucial for the implementation of an emergency preparedness programme. Severe lack of resources at the level of policy development and at the operations level could significantly reduce the effectiveness of the response in the event of an aquatic animal disease emergency. Awareness building at the level of policy-makers is essential to improve their understanding of the seriousness of aquatic animal disease problems to secure adequate priority at the national level. Equally important is improving the understanding by both governments and industries of the benefits from investing in emergency response systems.

REGIONAL INITIATIVES TO SUPPORT EMERGENCY PREPAREDNESS

Several past and ongoing collaborative regional initiatives (e.g. training programmes, workshops, master classes) have supported capacity and awareness building on aquatic animal health. The following section briefly highlights some of the key capacity and awareness building initiatives in the region that assist countries in dealing with aquatic animal disease emergencies.

The NACA/FAO/OIE Quarterly Aquatic Animal Disease (QAAD) Reporting System, participated by 21 countries, is one such example. To date, 22 quarterly issues have been published and widely disseminated in the region. The NACA/FAO/OIE disease list includes all diseases listed by the OIE plus other diseases of concern to the region. The OIE *International Aquatic Animal Health Code* (2004) lists 35 diseases of finfish, molluscs and crustaceans based on three criteria (i.e. consequence, spread and diagnosis) and which should be reported to OIE by member governments. The NACA/FAO/OIE Quarterly Aquatic Animal Disease (Asia-Pacific Region) Reporting System lists 44 diseases, including a number which are non-OIE listed (e.g. Koi herpes virus disease, abalone viral mortality and grouper iridoviral disease). The information generated through the regional reporting system provides up-to-date information on important diseases in the Asia-Pacific Region, serves as an early warning system for emerging diseases (e.g. KHV, TS) and can be a valuable source of information to support risk analysis.

Recognizing the increasingly serious socio-economic impacts and the possible consequences for international trade arising from disease incursions due to the introduction and spread of transboundary pathogens through the irresponsible movement of live aquatic animals, an Asia Pacific Economic Cooperation (APEC) Fisheries Working Group (FWG)-funded project (APEC FWG 01/2002) "Capacity and Awareness Building on Import Risk Analysis (IRA) for Aquatic Animals" was successfully implemented by NACA during 2002–2004 in partnership with several regional and international organizations. The project provided valuable regional training and learning opportunities for APEC economies, NACA and FAO member governments and participating regional/international organizations. Capacity on aquatic animal health

CV MOHAN

Red spot disease of grass carp may cause serious economic losses if not adequately controlled management, particularly risk analysis, was enhanced, which could lead to improved aquatic animal health policies and practices in the region. Important outputs include two significant publications: (a) a technical report (Arthur and Bondad-Reantaso, 2004) and (b) a risk analysis manual (Arthur *et al.*, 2004) that provides a simplified overview of the risk analysis process to assist responsible individuals in formulating national policies and developing approaches to conduct risk analysis.

A regional Advisory Group (AG) on aquatic animal health established by the Governing Council of NACA in 2001 is functioning proactively to move forward the implementation of the Technical Guidelines. NACA provides institutional support, while FAO, OIE and the identified experts provide technical guidance. The AG meets annually, and through its meeting recommendations (NACA 2004) provides specialist advice, especially on emerging diseases of concern to governments in the region. The recommendations serve as an early warning to countries in the region with susceptible species.

With the aim to maximize the utilization of existing resources in the region, a Regional Aquatic Animal Health Resource Base is being identified under the ongoing NACA regional initiative. The resource base in aquatic animal health is being identified at three levels: regional resource experts (RRE), regional resource centres (RRC) and regional reference laboratories (RRL). RRE is the first level of resource, and the identified experts will provide specialist advice to the region in their fields of expertise, assist in developing diagnostic manuals and disease cards, and provide diagnostic assistance on disease emergencies in the region. The second level of resource, the RRC, will not be specific for a single disease but will have good experience in diagnosing and studying aquatic animal diseases and pathogens. RRL is the third level of resource that would be identified for diseases of regional concern not listed by the OIE but included in the QAAD list. A cohesive networking among RREs, RRCs and RRLs in the region will provide an effective, strong and broad network of diagnostic support that will assist to build capacity for implementation of the Technical Guidelines. The envisaged resource base within the Asia Region would provide national agencies with assistance in the diagnosis of key diseases on the regional disease list, provide more generalized support, assist in emergency response to new disease outbreaks and act as contact centers for advice and capacity building in close cooperation with institutions having a mutual interest in improving aquatic animal health.

Pathogens associated with aquatic animal disease emergencies do not respect borders and can spread very rapidly from country to country. Countries in the region are starting to cooperate more closely in their efforts to minimize the impact of aquatic animal diseases. The recent workshop hosted by the Government of Malaysia in July 2004 in Penang, Malaysia, entitled "Building Capacity to Combat Impacts of Aquatic Invasive Alien Species and Associated Trans-boundary Pathogens in ASEAN Countries" is an example of such cooperation. Unless this is done, the disease control efforts of individual countries will be continually frustrated. Part of this cooperation should be the rapid sharing of information on new disease occurrences and the spread of existing epidemic diseases to new areas, particularly near shared watersheds. Therefore, there is a need to continue the strong regional cooperation in aquatic animal health in the Asia-Pacific Region.

CONCLUSIONS

Aquaculture has suffered significant losses due to diseases, and increasing risks are foreseen in the future as aquaculture continues to expand. Enabling governmental policies and commitment among stakeholders will help in managing aquatic animal disease emergencies. Many countries in the region still face significant challenges in the practical implementation of health management strategies, especially in the areas of surveillance, reporting, zoning, contingency planning and risk analysis. This is mainly due to inadequate national capacity and awareness. Bridging development gaps and capacity building across member countries is necessary. As development and implementation of an effective emergency preparedness and response strategy is a long-term process, continuous efforts to motivate and support governments and private industry in initiating their health management programmes is required. Capacity and awareness building activities to suit the regional aquatic animal health management needs should be continuously undertaken to sustain the good momentum built in the region. In particular, further support to national and regional initiatives for capacity building is essential.

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TABLE 2

The responsibilities involved at different levels and the capacity building required for contingency planning, early warning and emergency response (the purpose of the table is mainly to show the enormity of capacity building that will be required at different levels to effectively prepare a contingency plan and run an early warning and emergency response system. The table however does not represent a complete job description and capacity requirements.)

Contingency Planning		
People	**Responsibilities**	**Capacity Required**
National committees/ responsible authorities (e.g. Ministry of Fisheries, Department of Fisheries, Department of Livestock, fisheries research centers, fisheries teaching institutions, extension departments, private sector)	• developing national aquatic animal health strategies • identifying diseases of national concern • commissioning risk analyses on high-priority disease threats • developing technical plans for emergency preparedness (disease strategy manuals, general procedure manuals, enterprise manuals, job descriptions) • developing support plans for emergency preparedness (e.g financial, resource, legislation) • developing active disease surveillance & epidemiological analysis capabilities & emergency reporting systems • conducting training & awareness programmes	• qualified human resource with specialization in aquatic animal health (e.g. disease diagnostics, disease management, epidemiology, risk analysis, surveillance, zoning, disease treatments, biosecurity) • necessary laboratory infrastructure • access to information • financial resources
	• Ensuring operational capacity for early warning & emergency response (e.g. management manuals, diagnostic resources, capacity & awareness building)	• trained human resource for diagnostics (level II & III diagnostic capabilities), risk analyses, surveillance, epidemiology • adequate infrastructure • training resources • emergency field and laboratory services • adequate financial resources

Early Warning and Emergency Response				
People	**Responsibilities**	**Skills Required**	**Awareness Required to Support Skill Development**	**Capacity Required to Support Skill Development**
Pond/Farm Level (e.g. farmers, farmer associations, officers of the local disease control center)	• recognize a disease emergency • report to the concerned authority • initiate some early response • facilitate the implementation of response options suggested by the local/ national disease control centers	• ability to recognize an exotic disease • what constitutes a disease emergency? • skills to communicate the emergency to responsible authorities • skills to implement the suggested response options	• importance of disease emergencies & the need to report & initiate actions to contain such emergencies • socio-economic impacts of diseases, benefits of rapid containment	• Level I diagnostics (presumptive diagnosis based on history, clinical signs) • biosecurity principles • disinfection procedures • methods for safe destruction & disposal of affected animals
Village/District Level (e.g. extension staff, department officers, farmer leaders, research staff, officers of the local disease control center)	• recognize a disease emergency • report to the concerned higher authority • initiate some early response • implement the suggested response options	• knowledge of aquatic animal diseases • ability to recognize an exotic disease • what constitutes a disease emergency? • sampling & sample collection	• importance of disease emergencies & the need to report & initiate actions to contain such emergencies • socio-economic impacts of diseases, benefits of rapid containment	• Level I diagnostics (presumptive diagnosis based on history, clinical signs) • procedures for sampling & sample collection, preservation & transport • biosecurity • principles of monitoring & surveillance • disinfection methods • methods of safe destruction & disposal of affected animals

Early Warning and Emergency Response

People	Responsibilities	Skills Required	Awareness Required to Support Skill Development	Capacity Required to Support Skill Development
State/Province Level (e.g. research personnel, officers of main line departments, officers of state & provincial & disease control centers)	• identify a disease emergency • identify risks with exotic pathogens • confirm a disease emergency • report to the national authority • ensure implementation of suggested response options	• disease diagnostics • risk analysis • surveillance • epidemiology	• importance of disease emergencies & the need to report & initiate actions to contain such emergencies • consequences of failure • importance of systematic surveillance, risk analysis, reporting	• advanced training on aquatic animal health at graduate/post graduate levels • level II and III diagnostics • principles of risk analysis • epidemiology • organizing general & targeted surveillance programmes
National Level (personnel from national research laboratories, main line departments, national disease control centers)	• confirm disease emergencies • organize & coordinate surveillance systems for early warning • organize & coordinate disease reporting mechanisms • conduct risk analysis • develop national contingency plans for dealing with aquatic animal disease emergencies • ensure effective implementation of contingency plans • organize disease zoning • organize training & awareness programmes	• disease diagnostics • risk analysis • surveillance • epidemiology • disease management • information management	• importance of surveillance, risk analysis, epidemiology, disease reporting, etc to management of aquatic animal disease emergencies	• Advanced training & specialization in aquatic animal health at degree/postgraduate levels • level III diagnostics for listed diseases of concern to the country • designing & conducting risk analysis • designing & conducting surveillance programmes

National contingency plans for aquatic animal disease emergencies: the way forward for developing countries

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ABSTRACT

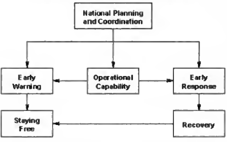
Infectious disease emergencies may arise within a country in a number of ways, for example: incursions of known exotic diseases, sudden changes in the behaviour of existing endemic diseases, or the appearance of previously unrecognized diseases. Contingency planning is critical to the effective management of such disease emergencies. A strong national approach is required to ensure that the necessary operational capability is in place so that early detection and effective responses are efficiently achieved. Recovery from an emergency disease response must be followed by measures to ensure that freedom from the particular disease is again maintained. This paper discusses each of these aspects.

INTRODUCTION

The epidemic spread and devastating impacts of white spot syndrome virus (WSSV) in cultured shrimp in Asia clearly demonstrated the vulnerability of aquaculture systems to wide-scale infectious disease emergencies. More recently, the widespread mass mortalities of koi and common carp in Indonesia have re-emphasized the impact that new diseases can have on local economies. Hopefully, the lessons learned from these experiences will result in better preparedness for, and improved responses to similar events when they occur in the future.

The role of contingency planning within a National Aquatic Animal Health Strategy is stressed in the "Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and the Bejing Consensus and Implementation Strategy" (FAO/NACA, 2000) and preliminary guidance to developing countries on the development of contingency plans is provided in the "Manual of Procedures for the Implementation of the Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals" (FAO/NACA, 2001). This paper discusses the components of a national contingency plan in greater detail.

FIGURE 1
Framework for emergency disease preparedness



Infectious disease emergencies may arise within a country in a number of ways, for example: incursions of known exotic diseases, sudden changes in the behaviour of existing endemic diseases, or the appearance of previously unrecognized diseases. Early warning and early response are critical to the effective management of such disease emergencies. A strong national approach is required to ensure that the necessary operational capability is in place so that early detection and effective responses are efficiently achieved. Recovery from an emergency disease response is followed by measures to ensure that freedom from the particular disease is again maintained. Figure 1 shows the linkages among these different components. Each of these is explained in more detail in the following sections.

NATIONAL PLANNING AND COORDINATION

In order to have emergency preparedness planning recognized as an important core function of government services, and to have adequate funding and other resources allocated to these activities, the responsible authority should enlist the support of all interested parties. These will include the relevant minister and senior ministry officials, other government departments and agencies including national economic development planning authorities, farming and fishing communities and organizations, seafood marketing authorities, processors, traders and exporters.

Of these, the most important target groups are the government and the farming and fishing communities. In presenting a strong case for support for emergency preparedness planning, the identified disease risks should be described together with the potential socio-economic consequences of an incursion of the disease. Additionally, the benefits that will result from more rapid containment and eradication of the disease outbreak through preparedness should be forcefully presented. The case should preferably be supplemented by a formal socio-economic cost-benefit analysis.

Responsibility for aquatic animal disease emergencies

The Responsible Officer recognized by the Office International des Épizooties (OIE or World Organisation for Animal Health) for the particular country should have overall technical responsibility with regard to preparedness for and management of aquatic animal health emergencies. This may be the Chief Veterinary Officer (CVO) or equivalent, such as the Director of Fisheries of the country. The appropriate government minister would of course be ultimately responsible.

National emergency disease planning committee

A National Emergency Disease Planning Committee (NEDPC) should be appointed to facilitate and coordinate emergency planning. This committee should be directly accountable to the relevant minister such as the Minister of Fisheries and should be charged with the responsibility for developing and maintaining a high state of preparedness for animal disease emergencies. It should preferably be chaired by the Responsible Officer and should hold regular meetings to carry out the following functions:

- commissioning of risk analyses on high-priority disease threats and subsequent identification of those diseases whose occurrence would constitute a national emergency;

- appointment of drafting teams for the preparation, monitoring and approval of contingency plans and other documents;
- liaison with, and involvement of, relevant persons and organizations outside the government aquatic animal health services who also have a role in aquatic animal disease emergency preparedness planning. Where they exist, this would include industry groups, the national disaster management authority, departments of economic planning and finance, environment and wildlife;
- enhancement of the capabilities of emergency field and laboratory services, especially for specific high-priority disease emergencies;
- development of active disease surveillance and epidemiological analysis capabilities and of emergency reporting systems;
- staff training and fisherman/farmer awareness programmes;
- assessment of resource needs and planning for their provision during disease emergencies;
- drafting of legislation and development of financial plans;
- implementation of simulation exercises to test and modify disease emergency plans and preparedness; and
- overall monitoring of the national state of preparedness for disease emergencies.

The NEDPC should comprise the Responsible Officer as chairman, the National Emergency Disease Planning Officer (see below) as secretary, director of field services/director of disease control (or equivalent), director of the national laboratory, head of the epidemiology unit, director of aquatic animal quarantine and directors of relevant state or provincial services.

In addition to these senior officials, representatives of other ministries that may have a substantial role in responding to aquatic animal disease emergencies, such as environment, wildlife services, economic planning and finance, should either be full members of the committee or should be co-opted as required. It is also highly desirable to have members drawn from the private sector, such as representatives of major fishing, farmer, processing and trading organizations.

National Emergency Disease Planning Officer

A National Emergency Disease Planning Officer (NEDPO) should be appointed. This officer should be a senior officer in the relevant department with training in epidemiology and wide field experience in the management of disease control programmes. If circumstances warrant it, a small unit of professionals should also be appointed to assist the NEDPO.

The planning officer would be both the adviser to, and the executive officer of the National Emergency Disease Planning Committee, and would be actively involved in all NEDPC programmes itemized above.

Aquatic animal disease emergencies as a component of the National Disaster Plan

Most countries have well-developed national disaster plans. These allow essential government and non-government services and resources to be rapidly mobilized in response to a disaster. Such plans may also allow these essential services to be given special powers to act in the emergency. The national disaster plan is usually aimed at specific natural disasters of an emergency nature such as major fires, floods, hurricanes, earthquakes and volcanic eruptions.

A strong case can be made for the official recognition of a disease emergency as a defined natural disaster situation that can be incorporated into the national disaster plan. An epidemic of an emergency aquatic animal disease, for example, has the same characteristics as other natural disasters: it is often a sudden and unexpected event, has the potential to cause major socio-economic consequences of national dimensions and even threaten food security, and requires a rapid national response.

EARLY WARNING

The aim of early warning is to rapidly detect the introduction of, or sudden increase in the incidence of any disease of aquatic animals that has the potential of developing to epidemic proportions and/or causing serious socio-economic consequences. It embraces all initiatives, mainly based on risk analysis and disease surveillance that lead to improved awareness and knowledge of the distribution and behaviour of disease outbreaks (and of infection) and which allow forecasting of the source and evolution of the disease outbreaks and the monitoring of the effectiveness of disease control campaigns.

Risk analysis

Risk analysis is something that we all do intuitively in our everyday life as well as in our professional work. Only recently has it developed into a more formal discipline and is increasingly used in many fields of endeavour. In aquatic animal health, it has perhaps been most widely applied in international trade to evaluate disease risks associated with imports. Import risk analyses are used in reaching decisions as to the most appropriate health certification and quarantine and other measures to be applied for imports into a particular country to produce an acceptable level of risk.

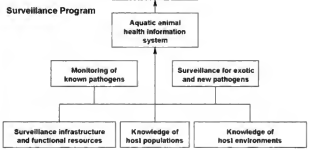
Risk analysis is a tool that can also be used to good advantage for animal disease emergency preparedness planning. International standards for import risk analysis are contained in the *Aquatic Animal Health Code* of the World Organisation for Animal Health (OIE, 2004) and a regional manual has recently been finalized (Arthur *et al.*, 2004).

Disease surveillance

Disease surveillance should be an integral and key component of all government aquatic animal health services. This is important for early warning of diseases, planning and monitoring of disease control programmes, provision of sound aquatic animal health advice to farmers, certification of exports, international reporting and verification of freedom from diseases. A comprehensive disease surveillance system provides a reliable picture of the health status of aquatic animal populations on an ongoing basis. It is particularly important for animal disease emergency preparedness.

Figure 2 provides a conceptual summary of the relationships among the broad components of a surveillance programme. This figure incorporates the OIE Code

FIGURE 2
Relationships among different components of a surveillance programme incorporating OIE Code concepts


Surveillance Program
Surveillance communication
Aquatic animal health information system
Monitoring of known pathogens
Surveillance for exotic and new pathogens
Surveillance infrastructure and functional resources
Knowledge of host populations
Knowledge of host environments

concepts of providing an effective surveillance infrastructure as well as including a description of host population and environmental characteristics.

EARLY RESPONSE

Early response is identified as all actions that would be targeted at rapid and effective containment of, and then possibly elimination of an emergency disease outbreak, thus preventing it from turning into a serious epidemic. There are three broad policy options for responding to emergency diseases; the option chosen for any particular disease will depend on many different factors. It may also be possible to use a combination of options in some instances. The options are:

- ***Eradication.*** Initial eradication of disease with eventual total elimination of the pathogen from the country, including silent infections, if they occur. This is the highest level of response but may not always be possible, especially where the disease is well established prior to the initial detection (i.e. where early warning has essentially failed).
- ***Containment*.**. Containment of the disease and pathogen to specified zones with control within infected zones and prevention of spread to uninfected areas of the country.
- ***Mitigation.*** Reduction of the impacts of the pathogen by implementing control measures at the farm level which reduce the occurrence and severity of disease.

Contingency plans

Countries need to have in place well-documented contingency action plans for specific, high-priority emergency diseases, together with a series of generic plans for activities or programmes common to the various specific disease contingency plans (e.g. setting up national and local disease control centers). They also need to have resource and financial plans and proper legislative backing for all actions. These contingency plans need to be considered and agreed upon in advance by all major stakeholders, including the political and bureaucratic arms of government and the private sector, particularly farmer organizations. The contingency plans should be refined through simulation exercises and personnel should be trained in their individual roles and responsibilities. The components of a contingency plan are shown in Box 1.

The relationships among the different contingency plan components are shown in Figure 3.

BOX 1

Components of a contingency plan.

Summary document

Technical plans

- Disease strategy manuals (one for each high priority disease)
- General procedures manuals
- Enterprise manuals
- Job descriptions

Support plans

- Financial
- Resource
- Legislation
- Other agencies

Operational capability

- Management manuals
- Diagnostic resources
- Training resources
- Awareness and education
- Response exercises

Operational capability

Developing and maintaining an operational capability to effectively and efficiently deal with emergency disease events is a major and continuing challenge. It is simply not possible to be prepared for all possible contingencies, but countries should aim to have an immediate capability for small to moderate outbreaks. The emphasis should be on having key personnel who are well trained and stakeholders who are responsible and aware of the nature of emergency diseases. The capability of different components of the system should always be subject to testing and review.

Response management

Manuals should be prepared that provide a management structure and an information flow system for the handling of an emergency disease emergency at national and local levels. It should describe the operations of control centers, providing principles for the chain of command, functions of sections and role descriptions. Management manuals may be prepared for:

- organization and operation of the national disease control center;
- organization and operation of local disease control centers; and
- emergency disease reporting and information systems, including mapping.

Diagnostic resources

Once the particular disease has been recognized as an emergency, the capability to make both presumptive field diagnoses with subsequent confirmation in the laboratory must be available. For disease threats that are a high priority, this capability must be in place in advance of disease outbreaks. The initial diagnosis will need to be confirmed in a laboratory, possibly even an international reference laboratory. For large outbreaks, it may not be possible to confirm the field diagnosis on every occasion once control and eradication measures are underway.

Field resources

To respond effectively to an emergency disease, personnel with a range of skills and experience are required. These include persons with the ability to undertake thorough disease investigations, tracing of animals and products and supervise operations on infected premises.

Training

All staff should be thoroughly trained in their roles, duties and responsibilities in a disease emergency. Obviously more intensive training will need to be given to those who will be in key positions. It should also be borne in mind that any staff member, from the Responsible Officer downwards, may be absent or may need to be relieved during a disease emergency for one reason or another. Back-up staff should therefore be trained for each position. Training of aquatic animal health staff in early recognition of emergency diseases and collection and dispatch of diagnostic specimens is a key component of preparedness.

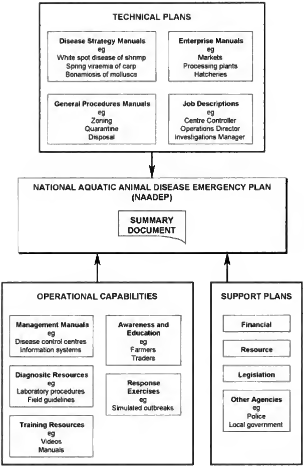
Awareness and education

This is one of the most critical, but sometimes neglected, aspects of preparedness planning for emergency diseases, and for fostering "ownership" and support for emergency disease control/eradication campaigns from farmers and other key stakeholders. It also engenders a "bottom up" approach to planning and implementation of disease control programmes, to complement the more traditional "top down" approach usually adopted by governments.

The communication strategies should aim to make stakeholders aware of the nature and potential consequences of important diseases and of the benefits to be derived from their prevention and eradication. Furthermore they should always have an element of rallying the community to the common cause of fighting a disease epidemic.

If at all possible, professional communicators and extension experts should be enlisted to help design and carry out awareness and publicity campaigns. Optimally, personal visits and discussions with farming and fishing communities, processors, traders etc are preferable, but media outlets such as newspapers, radio and television

FIGURE 3.
Relationships among different components of a National Aquatic Animal Disease Contingency Plan.



can reach a large target audience quickly. Radio programs have proven to be a very effective method for spreading the message. These should be broadcast at times of the day when most farmers could be expected to be listening to the radio - this may be early in the morning or at night.

Response exercises

Simulation exercises are extremely useful for testing and refining contingency plans in advance of any disease emergency. They are also a valuable means of building teams for emergency disease responses and for training individual staff.

Disease outbreak scenarios that are as realistic as possible should be devised for the exercises, using real data where possible (e.g. for farm locations, populations and trading routes). The scenario may cover one or more time phases during the outbreak with a possible range of outcomes. However, neither the scenario nor the exercise should be overly complicated or long. It is best to test just one system at a time (e.g. operation of a local disease control center). Simulation exercises may be carried out purely as a paper exercise or through mock activities – or a combination of both approaches. At the completion of each simulation exercise there should be a review to identify areas where plans need to be modified and further training is needed.

A full-scale disease outbreak simulation exercise should only be attempted after the individual components of the disease control response have been tested and proved. Earlier exercises of this nature may be counterproductive.

RECOVERY FROM AN EMERGENCY DISEASE

The process of recovery following the successful eradication of an emergency disease involves verification and international acceptance of national disease freedom as well as rehabilitation of farming communities.

Verification and international acceptance of disease freedom

The first and most important aim is to ensure that the causal agent of the disease (and not just the clinical disease) has been eradicated. There have been many occasions in which eradication efforts have been stopped when the disease seems to have disappeared. However small pockets of active infection have been left to smoulder. These have again flared up as susceptible populations again build up. This negates expensive control programmes.

It is therefore vital that as disease control measures diminish towards the end of the campaign, there be a shift of emphasis towards active disease surveillance to detect any residual infection. If vaccination has been used, this should be stopped so that there is no masking of infection.

When it is believed that infection has truly been eradicated, a series of verification programmes should be carried out. An important aim of these will be to provide objective proof to other countries and the international community as a whole that the country has regained freedom from the disease. This will provide the foundation for export trade in animals and animal products to be restored and/or developed.

This may involve:

- demonstration that the country has a capable aquatic animal health service and comprehensive disease surveillance programmes;
- statistically based surveys using laboratory tests for inapparent infection; and
- active clinical surveillance.

Reference should be made to the OIE Aquatic Animal Health Code for more specific guidelines on acceptable international disease freedom verification procedures for each disease.

Rehabilitation of farming communities

There will be a need to repopulate affected areas with disease-free animals, particularly if a "stamping out" campaign has been followed. The opportunity should be taken to introduce replacement animals that are not only free of the target disease but also of other important diseases. Consideration could also be given to upgrading genetic resources at the same time.

Special support mechanisms and programmes should be considered to allow affected farmers and farming communities to get back on their feet after a crippling disease outbreak. However, this could be regarded as a political rather than technical decision.

STAYING FREE

Lessons from the disease outbreaks and the campaigns to control and eradicate them should be learned so that the country will be in a better position to stay free of the disease and to respond more quickly and effectively to any further introductions.

A thorough review should be carried out while the events are still fresh in peoples' minds. This review should be led by the Responsible Officer and should include key representatives of both those involved in the disease control campaign (head office and local) and those affected by the disease outbreaks. Issues to be considered in the review include:

1. An epidemiological analysis of how the disease entered the country and the subsequent methods of spread with a view to strengthening quarantine and other preventive measures against the disease.
2. Based on the results of the above and on other experiences, a determination of how disease surveillance and other early warning procedures can be improved and on which geographical areas to concentrate efforts.
3. Revision of contingency plans for the disease.
4. Strengthening of public extension/education programmes.
5. Determination of whether legislative and other support frameworks need to be improved.
6. Further training programmes.

CONCLUSIONS

Having the capability to deal with emergency diseases involves a great deal of planning and training as well as having an appropriate level of resources mainly in the form of appropriately skilled personnel. Although a comprehensive capability in many countries will take a long time to achieve, foundations can be laid within the framework of whatever resources presently exist.

ACKNOWLEDGEMENTS

Material in this paper is consistent with the FAO Good Emergency Management Practices (GEMP) programme (www.fao.org/ag/AGA/AGAH/EMPRES/GEMP.htm), the OIE Aquatic Animal Health Code and the Australian emergency animal disease plans, AUSVETPLAN (www.aahc.com.au/ausvetplan/index.html) and AQUAVETPLAN (www.affa.gov.au/docs/animalplanthealth/aquatic/index.html).

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MSX disease emergency response: Canadian experience

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ABSTRACT

Canada has had several disease emergencies emerge in its aquatic animals. The first came in the early 1900s before recognition of disease and the need for control activities was clearly understood for aquatic animals. This set the foundation for Canada's aquatic animal health learning curve that has increased exponentially over the last 20 years as aquaculture activities have intensified and diversified into new species and environments. The earliest Canadian aquatic animal disease case-history is presented, along with Canada's most recent experience in 2002 with the first-time detection of the oyster disease MSX, caused by the microscopic parasite *Haplospordum nelsoni*, and a reportable disease listed by the World Organisation for Animal Health (OIE – Office International des Épizooties). Both are discussed in the context of theory and reality in dealing with aquatic animal disease emergencies that span multi-stakeholder interests and governmental jurisdictions.

INTRODUCTION

Canada has a long history of experience with aquatic animal disease management dating back to the 1915 emergence of Malpeque disease in oysters in Prince Edward Island (PEI). In the 1970s, Canada developed fish health protection regulations to provide health certification for the developing salmonid aquaculture industry. Parallel work was conducted with the International Council for the Exploration of the Sea (ICES) on wild fish diseases, on the management of outbreaks of infectious salmon anaemia (ISA) in the 1990s in New Brunswick and infectious haematopoietic necrosis (IHN) in Atlantic salmon in the Pacific, and on the study of aquaculture-wild disease interactions; up to Canada's most recent biosecurity challenge, returning once again to the oysters of Atlantic Canada, with the emergence of MSX disease caused by the protistan parasite *Haplosporidium nelsoni*.

The evolution of Canada's federal approach to aquatic animal biosecurity measures is based on these experiences and the increasing recognition of the need to be proactively prepared. The odds against successful disease eradication from open- or flow-through systems are low, but proactive response plans provide some assurance that the odds for a successful outcome are optimized.

CANADA'S INTRODUCTION TO AQUATIC ANIMAL HEALTH MANAGEMENT – MALPEQUE DISEASE

Canada's first experience of a significant aquatic animal disease pre-dates modern aquatic pathology, and aquaculture by almost 60 years. Mass mortalities of Eastern (American) oysters (*Crassostrea virginica*) occurred in Malpeque Bay, one of the major oyster-producing beds on Prince Edward Island (PEI) in 1915 (Needler and Logie, 1947). However, the mortalities were not recognized as being due to an infectious disease until it spread to neighbouring oyster beds on PEI via transplant activities in the 1930s. At this point, the disease became known as Malpeque Bay disease. Although the causative agent was not determined, the disease was reported to the Royal Society of Canada by Needler and Logie (1947) with the explanation: "*…this account is presented because of the rarity of recorded cases of mortalities in the sea attributable to contagious disease*". Ironically, the now internationally renowned "Malpeque oyster" derives its name from the same bay and from the survivors of the original Malpeque disease outbreak and 57 years later, mortalities in the sea caused by contagious disease are by no means rare.

Anecdotal evidence suggests that Malpeque disease may have been introduced via a massive transplantation of healthy oyster seed from New England in 1913–1914 (R.E. Drinnan, unpublished data). This was to help restore overfished oyster beds in Malpeque Bay. The first losses of over 99 percent of market-size oysters in Malpeque Bay occurred 12-18 months following the transplant. The fishery in the bay was closed and fishing effort moved to neighbouring oyster beds. Between 1935 and 1937, the oyster stocks in Malpeque Bay recovered to a level where they could be commercially fished again, and seed were transplanted into neighbouring bays. Malpeque disease re-emerged, virtually wiping out the remaining PEI oyster fishery, and indicating that an infectious agent was being carried by the apparently healthy oysters from Malpeque Bay. The first Canadian aquatic biosecurity control measure was put into place – a complete prohibition of any oyster transfers out of PEI (Needler and Logie, 1947).

By the mid-1950s, the PEI oyster beds had again recovered, and the first lesson in biosecurity risks was learned: human memory can rarely keep disease risk in perspective when high-risk stocks appear healthy. The jump of Malpeque disease from PEI to mainland Atlantic Canada in 1957 is attributed to unsanctioned transfers of oysters for processing in southwestern New Brunswick.

The response to this emergency was one that would attract strong debate today. Spread of the disease to neighbouring New Brunswick and Nova Scotia oyster beds was considered to be unpreventable because of southern Gulf of St. Lawrence hydrography and an inability to differentiate healthy carriers from uninfected oysters. Therefore, Malpeque disease-tolerant oysters from PEI were actively spread throughout the southern Gulf of St. Lawrence (Found and Logie, 1957; Drinnan, 1967). This was considered to be the most effective way of accelerating recovery of oyster stocks that were inevitably going to succumb to the disease.

This strategy worked, and the southern Gulf of St. Lawrence now produces ~7 000 tonnes of healthy, Malpeque disease-tolerant oyster populations, worth approximately CAD$ 10-15 million. Clinical signs of the disease are rare, and only naïve stocks from neighbouring Cape Breton waters (transplanted for experimental purposes) succumb to the disease, usually within 12-18 months (McGladdery and Stephenson, 1999, McGladdery and Bower, 1999).

Many organisms and aetiologies have been attributed to Malpeque disease (Li *et al.*, 1980), with current research indicating a possible cryptic viral or microcellular protistan aetiology (McGladdery and Bower, 1999); however, the causative agent has defied conclusive identification. Furthermore, the single generation inheritance of tolerance in offspring of the few survivors of initial exposure and the lack of a microscopically evident or culturable microbial agent have both complicated understanding of the disease. Recent transmission experiments, however, have demonstrated that the causative agent remains virulent for naïve oysters 40 years after the last clinical outbreaks (McGladdery and Stephenson, 1999). These transplant experiments, however, were abruptly halted in 2002 when MSX disease (caused by *Haplosporidium nelsoni*) was detected for the first time in oysters from inner Cape Breton waters.

In conclusion, Canada's introduction to aquatic animal health biosecurity is founded on an aetiological mystery.

EIGHTY-SEVEN YEARS LATER – MSX: AN EMERGENCY PREPAREDNESS CASE STUDY

The model contingency plan

In September 2002, a joint Fisheries and Oceans Canada (DFO) – Canadian Food Inspection Agency (CFIA) presentation was made at the Aquaculture Association of Canada's annual Aquaculture Canada^{OM} meeting, in Charlottetown, PEI.[1] A model contingency plan for a disease listed by the World Organisation for Animal Health (OIE - Office International des Épizooties OIE) that would pose a serious threat to a commercially significant species in Canada was presented. This was aimed at defining roles, responsibilities and resource requirements to address a disease emergency within the context of Canada's proposed National Aquatic Animal Health Partnership (NAAHP).

The model chosen was MSX disease of eastern oysters (*Crassostrea virginica*). This was considered to be a "worst case scenario" because detection of light infections is difficult using routine screening techniques (light microscope histology), mechanism(s) of transmission are unknown, and infections affect cultured and wild oyster populations. In addition, oyster production spans federal and provincial authorities, First Nations' traditional food fisheries, commercial fisheries, licensed aquaculture lease-holders, processing plants and brokerage operations, and roadside/retail marketer activities. In summary, control of MSX, if detected in open-water oysters, would be extremely "problematic" and involve a wide diversity of stakeholder interests.

Meanwhile back at the lab

Oyster samples from St. Patrick's Channel, Bras d'Or Lake (Figure 1), submitted to the DFO Shellfish Health Unit in Moncton due to reports of increasing levels of mortality over 2002, revealed plasmodia-like inclusions that had not been found previously in Canadian oysters. The high levels of infection (prevalence and intensity) along with intense haemocyte infiltration indicated that this was the likely cause of the mortalities being reported.

Histopathology samples were immediately sent to the Pacific Biological Station (PBS) in Nanaimo, British Columbia, and the Oxford Maryland Cooperative Laboratory. Histopathology and tissue samples preserved for molecular analyses were also sent to the OIE reference laboratory at the Virginia Institute of Marine Sciences (VIMS), Williamsburg, Virginia.

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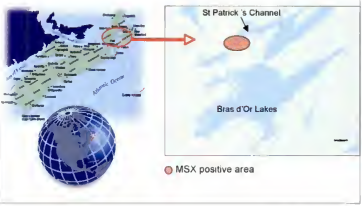
[1] McGladdery S.E., McVicar, A.H. & Warrell, W.S. Disease control models for the proposed National Aquatic Animal Health Program. Aquaculture CanadaOM 2002, October 21, 2002, Charlottetown, PEI.

FIGURE 1
Cape Breton, Nova Scotia and area where MSX was first detected



A working contingency plan

Initiation of the plan prior to diagnostic confirmation

The model contingency plan outlined at the Aquaculture Canada meeting was converted to a working contingency plan prior to official confirmation of the diagnosis. It contained actions required on "suspicion" of infection as well as those required on confirmation (or negation) of the diagnosis.

A critical first step was the appointment of a senior manager to compile the emergency response team (the MSX Task Group) and coordinate all activities. This person was selected on the basis of their knowledge of the industry and given the authority to make decisions and discuss options and recommendations directly with senior management (DFO regional and national management, as well as provincial aquaculture managers). The MSX Task Group consisted of key DFO and provincial personnel and was tasked with:

i) contacting the directly affected stakeholders; and
ii) preparing information for the public and for media communications.

This senior DFO coordinator was essential for permitting science expertise to concentrate on development of appropriate surveillance programmes and laboratory analyses protocols.

Conversion from suspect to confirmed diagnosis

As soon as MSX was confirmed by the OIE reference laboratory for molluscan diseases at VIMS, the Chief Veterinary Officer (CVO) for Canada was notified. The Office of the CVO immediately prepared an advisory note that was sent to OIE Headquarters in Paris. The report provided the known geographic extent of infection, mortality levels being reported, the contingency plan, and surveillance plans for delineating the exact geographic extent of the distribution of MSX in Canadian oysters. This advisory made Canada positive for MSX until the emergency surveillance could demonstrate which oyster stocks were not infected (Stephenson and McGladdery, 2002).

This model contingency plan doubled in size over the period of October 2002 to February 2003 from a six page document to the current plan, as results and tracking of stock movements evolved. Revisions are ongoing as results from positive, buffer and negative zones (established following the emergency targeted surveillance programme) continue to emerge.

Consultation and containment

A meeting was arranged close to the affected site with Cape Breton oyster growers, First Nations, and provincial and federal fisheries and seafood authorities. An overview of what was known about MSX was presented and the possible scenarios for introduction of the disease were discussed. This was considered to be an essential first step in getting to know the local faces involved and letting them know who the emergency response team were. It was also an important discussion for putting the outbreak into a socio-economic as well as epidemiological context. The history of who was working with whom, and moving which stock where, was an essential foundation for developing the surveillance programme required. It was also useful for identifying key stakeholder representatives to participate in the plethora of conference calls required to keep as many key people informed in as timely a manner as possible.

Based on an absence of evidence that MSX had been present historically (DFO surveillance of oyster mortalities since the 1930s), the hypothesis was of a recent introduction; however, surveillance data were needed to determine if this was linked to a point-source or to a wider-spread introduction. The appearance of MSX within the Bras d'Or Lakes system, which is more or less completely land-locked, suggested a link to human activities rather than climate change or oceanographic influences. Further, the known affected area is adjacent to a mining operation using cargo vessels carrying ballast from the eastern United States where MSX is endemic. Although the high mortalities and lack of historic evidence of infection were indicative of an exotic disease occurrence, this was considered insufficient alone to negate the possibility of a historic presence, especially of subclinical infections or unreported/unobserved oyster mortalities. An attempt to eradicate MSX from the affected sites was also discussed, but considered premature until the actual extent of infection was better known.

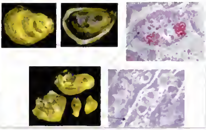
Pending collection of more data, it was important to contain spread from the known affected areas and areas that had direct oyster transfer links. Since the detection coincided with the peak period for harvest for the Christmas market, control of these activities was a priority. The commercial fishery was already closed for conservation purposes, so the only harvesting activity was by lease-holders and First Nations. Fisheries and Oceans and the Nova Scotia Department of Agriculture and Fisheries (NSDAF) agreed to withdraw harvest licenses and develop protocols that would permit oysters that were fit for market to be harvested safely. On finalization, these Harvest Protocols were posted on the DFO website to permit public access (www.dfo-mpo.gc.ca/science/aquaculture/msxdisease/msx_handle_e.htm). First Nations voluntarily stopped their food fishery for oysters.

Preparation of an emergency surveillance programme

Using the information on hand, surveillance was aimed at determining how far the disease could have spread outward from the known infection area. Surveillance priorities focused on current and recent oyster transfers within and out of Cape Breton waters. Transfer pathways into the southern Gulf of St. Lawrence and to PEI in the previous two years for live-holding, processing or depuration relay were also identified. Neighbouring provinces were alerted and included in surveillance collections.

As "controls" for possible transfer-activity related MSX spread, oyster samples from areas with no direct contact with Cape Breton oysters were included in the surveillance programme. Lastly, mussels (*Mytilus edulis*) close to oyster beds known to be positive for MSX were also included. This was due to concerns about the potential for non-oyster transfers with other Cape Breton aquaculture-related activities, notably those of mussels where leases are located in the same bays as oyster beds or aquaculture operations.

FIGURE 2
Histopathological detection of MSX in eastern oysters (*Crassostrea virginica*) from Cape Breton



Emergency surveillance: sample collection and analysis

Sampling procedures and collection design were developed by the NSDAF in consultation with the DFO Shellfish Health Unit at the Gulf Fisheries Centre (GFC). Sites in Cape Breton farthest away from the known affected sites were sampled first. Two teams of personnel trained by the provincial veterinarian visited a maximum of two sites per day, using on-site wet gear, boats and harvesting equipment. All materials transferred between sites by the collection team, including vehicles, were disinfected between sites. New Brunswick and PEI provincial fisheries and aquaculture authorities assisted with collections from their provinces. These collections extended into winter months, despite the challenge of remote winter travel and sampling at sub-zero temperatures through ice. The samples were examined by shellfish pathologists at the DFO laboratory in Moncton and PBS Nanaimo. Sample receipt, processing, histopathological screening (Figure 2), data recording and polymerase chain reaction (PCR) subsample analyses were undertaken in accordance with detailed guidelines prepared in advance by the GFC Shellfish Health Unit. Equipment was standardized to ensure that effort and results between different inspectors and analysts were consistent. This included microscope objective magnifications, the number of runs through automatic staining machines for optimal counter-stain contrast and the reagents used for DNA extraction from tissue homogenates for PCR and for *in situ* hybridization analyses.

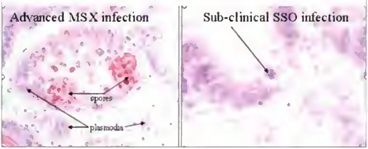
Due to winter temperatures being associated with lighter levels of infection in oysters in endemic waters along the eastern United States, confidence in negative results from routine microscopic examinations was low – especially those collected from beds close to known positive sites or with direct links to affected sites. Tissue samples from all oysters for the initial emergency surveillance were preserved for PCR using sterile technique to prevent cross-specimen contamination, prior to collection of tissues destined for both light and electron microscopy.

Histopathological examination procedures were developed to ensure coverage of the greatest geographic range as possible for heavy/conclusive infections. Thus, 30 oysters from each sample of 60 were examined at low and low-medium magnification – considered sufficient to detect heavy infections. Once all samples had been screened at this level, all negative samples were re-examined at high-dry magnification for light infections that could have been missed at the lower microscope magnifications. A third examination was made by another pathologist on any subclinical or inconclusive infections, for confirmation purposes. Some inconclusive samples were also sent to the OIE reference laboratory and Dr Susan Ford of the Haskin Shellfish Research Laboratory at Rutgers University, who was invited to meet with Cape Breton stakeholders by First Nations early in November 2002 to provide a first-hand account of dealing with MSX in the United States.

The remaining outstanding 30 oysters from samples that were negative after the low and high-power sweep were examined to confirm the absence of MSX from the tissue examples submitted. Lastly, subsamples of tissues preserved in 95 percent ethanol from negative oysters, along with all oysters showing inconclusive plasmodia-like tissue inclusions, were examined using PCR.

Throughout each analysis stage, a central logbook tracked sample possession and sample step. Positive infections indicated a positive sample, but further analysis for prevalence and intensity was deferred until all samples had been analysed.

FIGURE 3
Classic MSX and sub-clinical SSO oyster infections



Communications and reporting of emergency surveillance results

Conference calls were held on a daily basis over the first few weeks while Harvest Protocols were finalized and surveillance collections were being made. Separate conference calls were needed for internal briefing of DFO (Ottawa and Area offices in Nova Scotia, New Brunswick and PEI); and for provincial and industry stakeholders. Up to five hours a day were spent ensuring everyone was briefed over October and November. The frequency of the calls was reduced over December and January to weekly and bi-weekly. Since March 2003, the calls have been limited to updates on results every few months or when new information is found.

The results from the initial emergency surveillance were completed in November 2002 and released according to a media communications plan. These showed two apparent levels of MSX infection. One was the classic MSX infection with plasmodial proliferation throughout the connective tissues and digestive tubules, some of which also showed spore development (Figure 3). These infections were found exclusively in oysters that had direct contact with the infected oysters in St. Patrick's Channel. A second type of infection, showing isolated plasmodia with no sign of proliferation or haemocyte infiltration response, was also detected. This was reported as "suspect MSX", but since MSX PCR analysis of these infections was all negative, it was emphasized that they required further investigation. Negative PCR results had also been obtained from lighter MSX infections, so the possibility of false negatives as well as false positives needed further analysis. The significance of the suspect infections was that they were outside Cape Breton, but in oysters that had transfer links (direct and indirect) with Cape Breton oysters.

Tests performed using the PCR primer for sea side organism (SSO) disease of oysters caused by *Haplosporidium costale*, a close relative of the MSX organism, confirmed the presence of the SSO parasite in oysters from PEI and the north shore of Cape Breton outside Bras d'Or Lakes. These infections were all light (1-3 plasmodia per tissue section) (Figure 3) and had no obvious links to the MSX outbreak in Cape Breton. PCR analysis of the first samples submitted from Cape Breton in late September used both MSX and SSO primers. Since SSO was listed by the OIE as one of a number of "other significant diseases" for molluscs in 2002, this was also reported to the OIE as a new finding for Canada. This was given the caveat that none of the infections were associated with clinical disease.

Additional samples were collected overwinter from wild and cultured oyster beds in Cape Breton, Nova Scotia, southwest Nova Scotia, the Bay of Fundy and the southern Gulf of St. Lawrence (New Brunswick, PEI and the Magdalen Islands, Québec). The results from all analyses, plus those conducted in early spring 2003, showed no change in the geographic distribution of MSX, but added more areas with subclinical SSO infections (Figure 4).

Control options and considerations

Given the apparently limited distribution of MSX, the feasibility of eradication was considered. A potential window of opportunity existed for oyster depopulation at affected sites in early May 2003, following the spring thaw and before temperatures and salinities rose to levels conducive to MSX proliferation (> 10 °C). However, eradication was judged unrealistic given that:

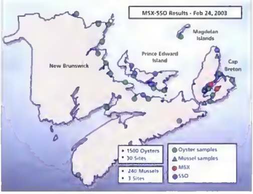
- all oysters (spat to adults) from affected areas would need to be removed,
- the intermediate host or reservoir of infection was unknown, and
- the method of introduction of MSX into Bras d'Or Lakes was unknown.

The high potential for failure via unharvested oysters, unknown reservoirs, and the inability to prevent subsequent re-introduction of the infection if eradication was successful, meant this would not be worth the effort. However, the decision not to pursue depopulation meant that Bras d'Or Lakes became an MSX-positive zone, encompassing both positive sites and those sites that had not tested positive.

Control options based on this MSX-positive zone designation had to be developed. Firstly, all Introduction and Transfers Committees (ITCs) were notified of the need to refuse transfer licenses for oyster movement out of Bras d'Or Lake waters. This reinforced the controls in place through the Harvest Protocols, since Bras d'Or Lakes are a naturally contained water body, nestled at the center of the Cape Breton Highlands with a narrow northern passage to surrounding Atlantic waters (Figure 1). This natural geographic containment is conducive to management of active transfer activities. Federal surveillance efforts would concentrate on a designated buffer zone surrounding Cape Breton, to ensure early detection of any emergence of MSX outside Bras d'Or Lakes.

With respect to control of oyster movements within Bras d'Or Lakes, "like to like" transfer is considered an acceptable risk for disease management, but required regional surveillance effort, with coordination between DFO Area Offices in Cape Breton and the Nova Scotia Department of Agriculture and Fisheries (NSDAF). DFO's Shellfish Health Unit has provided diagnostic guidance to the Unama'ki Institute of Natural Resources at Eskasoni and the NSDAF veterinary pathology laboratory at Truro to assist with oyster disease management within Bras d'Or Lakes. Consideration was given to mass transplantation of infected stock around Bras d'Or Lakes, for the same reasons applied to the question of management of Malpeque disease in the 1950s – i.e. to accelerate spread of the disease and depopulate remaining naïve stocks. However, with no concrete evidence of tolerance in surviving oysters in Cape Breton and over 40 years of research yielding mixed results from selective breeding for resistance to MSX in the United States (Sunila *et al.*, 1999, Ragone-Calvo *et al.*, 2003), the control option was considered to be premature.

FIGURE 4
2002-2003 distribution of MSX and SSO infections in Atlantic Canada



There also remained hope that the particularly severe winter of 2002/03 may have taken a natural toll on MSX, since 2003 proved to be the worst year in a decade for "winterkill". This flooded the diagnostic laboratory with samples for analysis in light of MSX concerns, with no MSX detected until its re-emergence in oysters from Bras d'Or Lakes in the early summer of 2003.

No restrictions of introduction and transfers of live oysters or shell were developed for oysters in areas determined to be positive for SSO. Surveillance efforts mapped subclinical infections at very low levels of prevalence (< 5 percent) and intensity (< 3 plasmodia/tissue section), along with their apparent diffuse distribution in oysters from around Atlantic Canada (including a single co-infection found in Cape Breton). These infections appear to pose no clear risk to apparently uninfected oysters in Atlantic Canada. The molluscan histopathology collection at GFC will be examined to determine whether or not SSO was present in Atlantic Canadian oysters prior to 2002, but unrecognized until the PCR analyses of 2002/03. A haplosporidian was reported from a single mussel from PEI in 2002, but this showed no molecular affinity to either MSX or SSO (Stephenson *et al.*, 2003).

One of the most challenging control debates centered on whether or not transfer restrictions should be applied to other species in the MSX-positive zone. This discussion is not new to Canada. Transfers of scallops from ISA-endemic areas and mussels from Malpeque endemic areas have been subject to similar debate. ISA screening of scallops used sensitive salmonid cell-lines. Malpeque disease risks from mussels used oyster "canary" sentinels. Neither proved positive for carriage of virulent infectious agents of the diseases of concern. However, mussel transfers were prohibited pending PCR analysis of mussels located near the most heavily MSX-positive oyster beds in late 2002, as well as in the summer of 2003. Neither these, nor samples examined from other locations in Cape Breton, showed any evidence of the presence of *H. nelsoni* or *H. costale*. Thus, no restrictions on movements of other molluscs out of the MSX-affected zone were made subject to normal conditions of transfer that include washing on site prior to transfer for processing, to reduce the risk of inadvertent transfer of fouling organisms (such as juvenile oysters) that might transmit these parasites.

Another control option that received detailed consideration was importation of resistant strains or species of oyster from the United States. However, physiological adaptation of a more southerly population to the growing conditions in Bras d'Or Lakes, along with concerns about introduction of other diseases, meant this option was considered premature.

Current status

The winter of 2002/03 was the hardest salt-water freeze-over experienced in Atlantic Canada for a decade. The spring thawing of the deep ice and snow cover reduced the salinities within the lakes to < 15 ppt until late into May-June in many bays. However, heavy infections were detected again in oysters from St. Patrick's Channel and other sites within Bras d'Or Lakes by June 2003. These infections have persisted into 2004.

No MSX has been detected in oysters sampled outside Bras d'Or Lakes waters. Thus, the remaining oyster-producing areas in Atlantic Canada are considered negative at the time of writing. Surveillance is being continued throughout Atlantic Canada, with emphasis on the buffer zone. All mortalities from these areas are examined for both MSX and SSO.

The controls put into place continue to restrict leaseholders to harvesting their oysters under stringent guidelines, although options have now been expanded to permit processing outside Cape Breton within a federally registered processing plant with effluent treatment controls. Signed agreement to these procedures is still required from both harvester and processing plant owner/manager. Marketing for direct human consumption is now permitted anywhere, including east of Québec City.

While the disease still exists, success in preventing spread is limited at best and vulnerable to ignorance or deliberate circumvention. Imposing restrictions on one sector of an industry with the significant economic impacts this incurs, while neighbours conduct business as usual, requires strong risk communication to avoid "mutiny" and non-compliance.

A post-mortem on the contingency plan: managing expectations

The technical aspects of the programme ran relatively smoothly, despite the emergence of SSO in the midst of the MSX-driven survey. The greatest problems arose (and continue to plague government) in managing expectations, especially those surrounding communications and the impacts that MSX controls have had on traditional oyster fishing and harvest practices.

Communications with the media, government departments and area offices, and senior management and with the laboratories involved centered on the two lead shellfish pathologists at the DFO Gulf Fisheries Centre (GFC). Despite strong coordination support from management, some stakeholders fell through the cracks. Initial focus was on Cape Breton and the principle affected lease-holders. On determining links to neighbouring provinces, they expressed concern that they had not been advised immediately. Likewise, the commercial harvesters were angry at not being included in the initial discussions, even though the fishery was closed. These would be considered to be oversights that need to be addressed in contingency plan revisions.

Another communication problem encountered was how to release results from the survey. Individual growers assisted greatly with the official collections and expected the Shellfish Health Unit to contact them individually as results were completed. Instead, it was decided to batch-release results, to permit DFO to prepare communications for senior managers, the media, the provinces and other stakeholders. This was seen as an unnecessarily stressful delay for the growers participating in the surveillance programme, and a lot of time was spent away from the microscope on the phone explaining the situation to individual growers, their family friends and neighbours! The historic accessibility of the shellfish pathologists, which served well in getting strong collaboration with initial harvest closures and surveillance protocols, was detrimental to the time needed for laboratory analysis. "Surge protection" for both communications as well as diagnostic work was considered to be a significant challenge that needs to be addressed for future emergency preparedness.

Batch results were released using a pre-agreed upon step-wise approach:

- Advise federal senior management.
- Advise internal DFO MSX working group – coordinator and area offices.
- Hold a DFO-Provincial conference call (provincial representatives advise senior provincial managers).
- Inform any stakeholders with positive or suspect results individually.
- Release results via conference call with key industry representatives.
- Release results to the media.

The hardest information to deal with was the inconclusive results in November. Ideally, these should not have been released, but pressure from government, industry and the media for follow-up to the October announcement of detection of MSX required as rapid a release of information as possible. The analyses undertaken were aimed specifically at detection of heavy (classic) infections and were given the strict caveat that no results were "truly" negative at this point. The detection of the cryptic plasmodial infections was unexpected. These could have been reported as "incomplete" rather than "suspect", but the fact that they demonstrated previously undetected plasmodia and indicated a potential broader distribution requiring precautionary measures (as applied on suspicion of MSX) meant they were reported as "inconclusive" and "very different from the MSX infections in Cape Breton". Expert opinion from the United States had confirmed that the plasmodia looked like MSX prior to the release of the results.

This conundrum was exacerbated by the fact that the PCR analyses were being field validated in the midst of the emergency surveillance. Inconclusive histology was reinforced by negative PCR. Experience from these analyses formed the basis for refinement of both the SSO and MSX primers recommended by the OIE.

As mentioned above, the shortage of experienced resources to cope with the "surge effect" generated by both laboratory and communication needs was a critical issue that needs to be addressed for any future disease emergencies. This is reflected in the three-phase surveillance approach that is being actively pursued by training more shellfish pathologists at local universities and the Unama'ki Institute of Natural Resources.

CONCLUSIONS

Canada's history of experience with Malpeque disease, as well as many other molluscan diseases on both coasts, served well in knowing the key stakeholders to involve. In addition, senior government management (federal and provincial) was quick to respond with support for the activities required. Likewise, the expertise from the United States, France and New Zealand all provided generous and invaluable support for technical discussions as well as review of risk assessments and control options.

The unknown issues that haunt molluscan health protection technically, epidemiologically and with respect to multi-user stakeholder interests also apply to new species (finfish, molluscs, crustaceans, echinoderms etc.) coming under increasing domestication and live transfer activities. It is hoped that some of the experience gained during this exercise is of use for the Koi herpes virus discussions in Indonesia.

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FAO FISHERIES PROCEEDINGS **4**

Regional Workshop on Preparedness and Response to Aquatic Animal Health Emergencies in Asia

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